



US006460705B1

(12) **United States Patent**  
**Hallowell**

(10) **Patent No.:** **US 6,460,705 B1**  
(45) **Date of Patent:** **Oct. 8, 2002**

(54) **METHOD OF CREATING IDENTIFIABLE  
SMALLER STACKS OF CURRENCY BILLS  
WITHIN A LARGER STACK OF CURRENCY  
BILLS**

(75) **Inventor:** **Curtis W. Hallowell, Palatine, IL (US)**

(73) **Assignee:** **Cummins-Allison Corp., Mt. Prospect,  
IL (US)**

(\*) **Notice:** Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 0 days.

(21) **Appl. No.:** **09/635,181**

(22) **Filed:** **Aug. 9, 2000**

(51) **Int. Cl.<sup>7</sup>** ..... **B07C 5/00; B07C 5/34**

(52) **U.S. Cl.** ..... **209/534; 209/540; 209/542;  
209/545; 271/65; 271/185; 271/186**

(58) **Field of Search** ..... **209/534, 540,  
209/542, 545; 271/65, 185, 186; 270/52.02,  
58.04, 52.01, 58.01**

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*Primary Examiner*—Donald P. Walsh

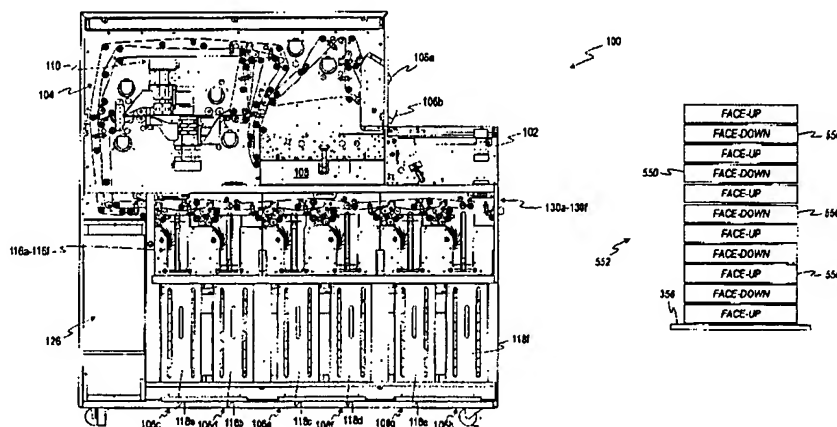
*Assistant Examiner*—Jonathan R Miller

(74) *Attorney, Agent, or Firm*—Jenkins & Gilchrist

(57) **ABSTRACT**

A method and device for identifying small stacks of cur-  
rency bills within a large stack of currency bills using a  
currency evaluation device. A stack of currency bills to be  
processed is received in an input receptacle and the bills are  
transported from the input receptacle, one at a time, past an  
evaluating unit to at least one output receptacle. The evalu-  
ating unit determines the face orientation of each of the bills.  
Next it is determined whether the face orientation of each of  
the bills matches a target orientation. If the face orientation  
of a bill matches the target orientation, the face orientation  
of that bill is maintained. If the face orientation of a bill fails  
to match the target orientation, the face orientation of that  
bills is reversed with a bill facing mechanism. Each of the  
bills are then stacked in the output receptacle. After a  
predetermined number of bills having a common face ori-  
entation are stacked in the output receptacle, the target face  
orientation is redefined. The bills continue to be processed in  
this manner until each of the bills are transported from the  
input receptacle.

**66 Claims, 30 Drawing Sheets**



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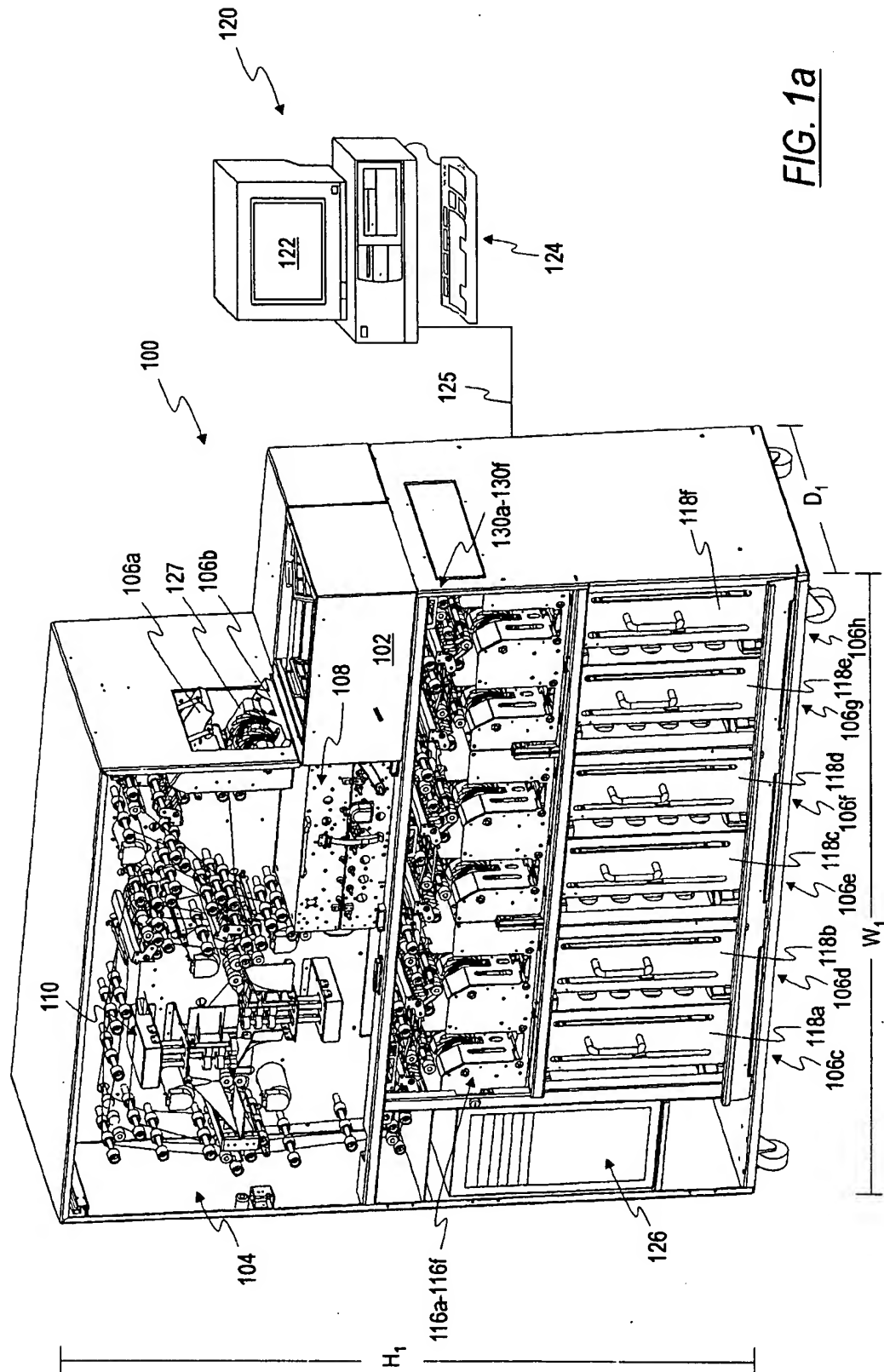


FIG. 1a

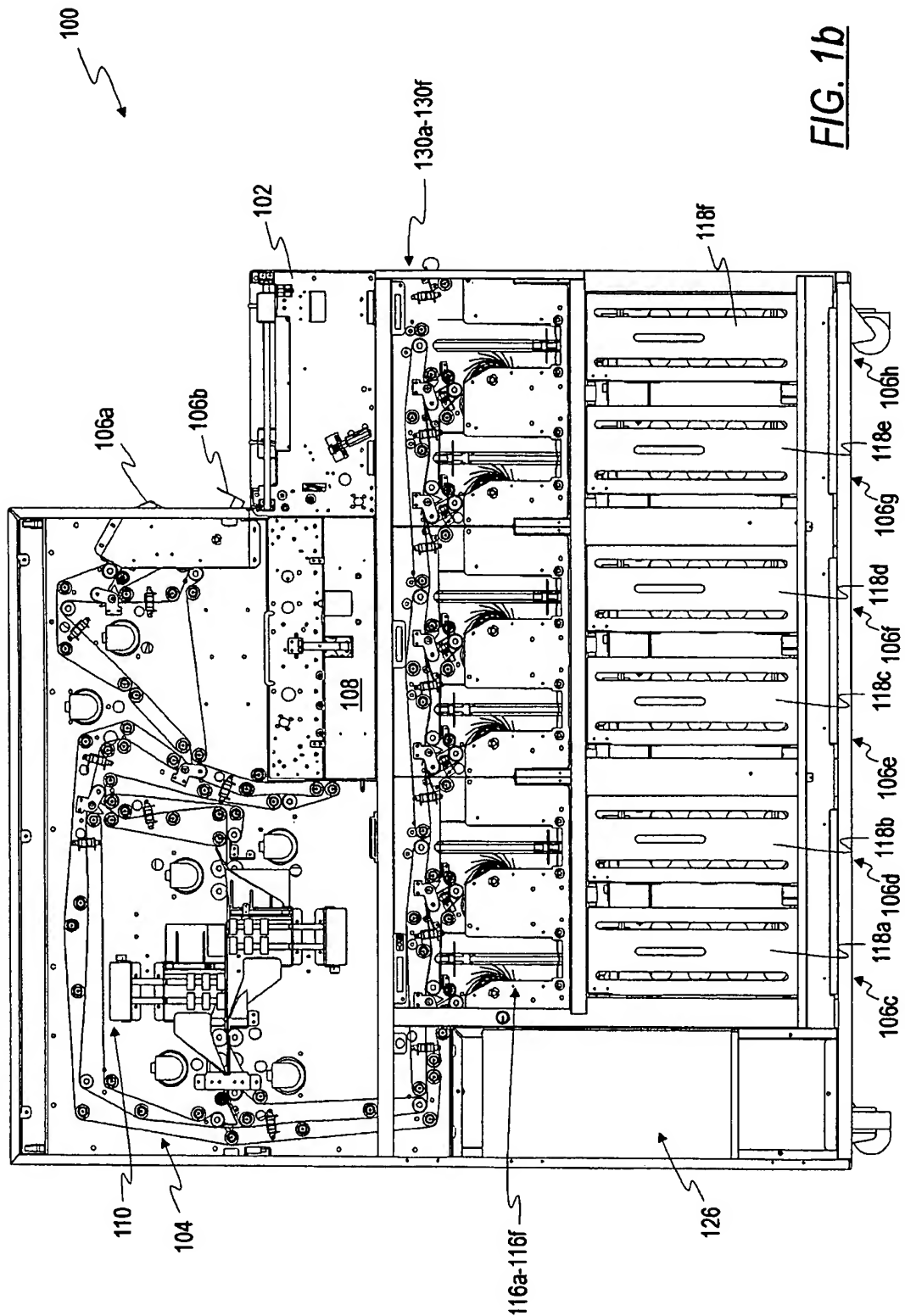
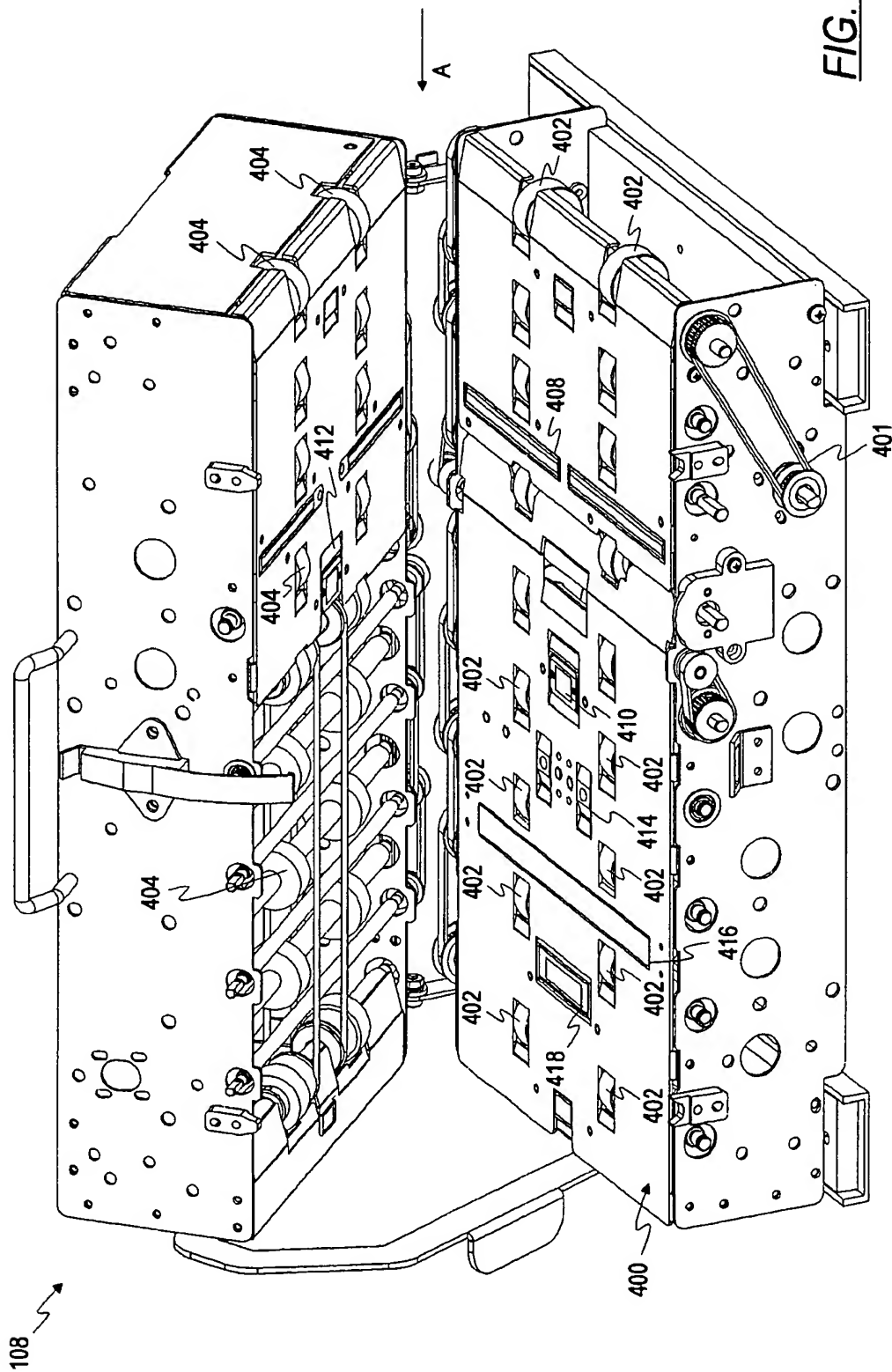


FIG. 2a



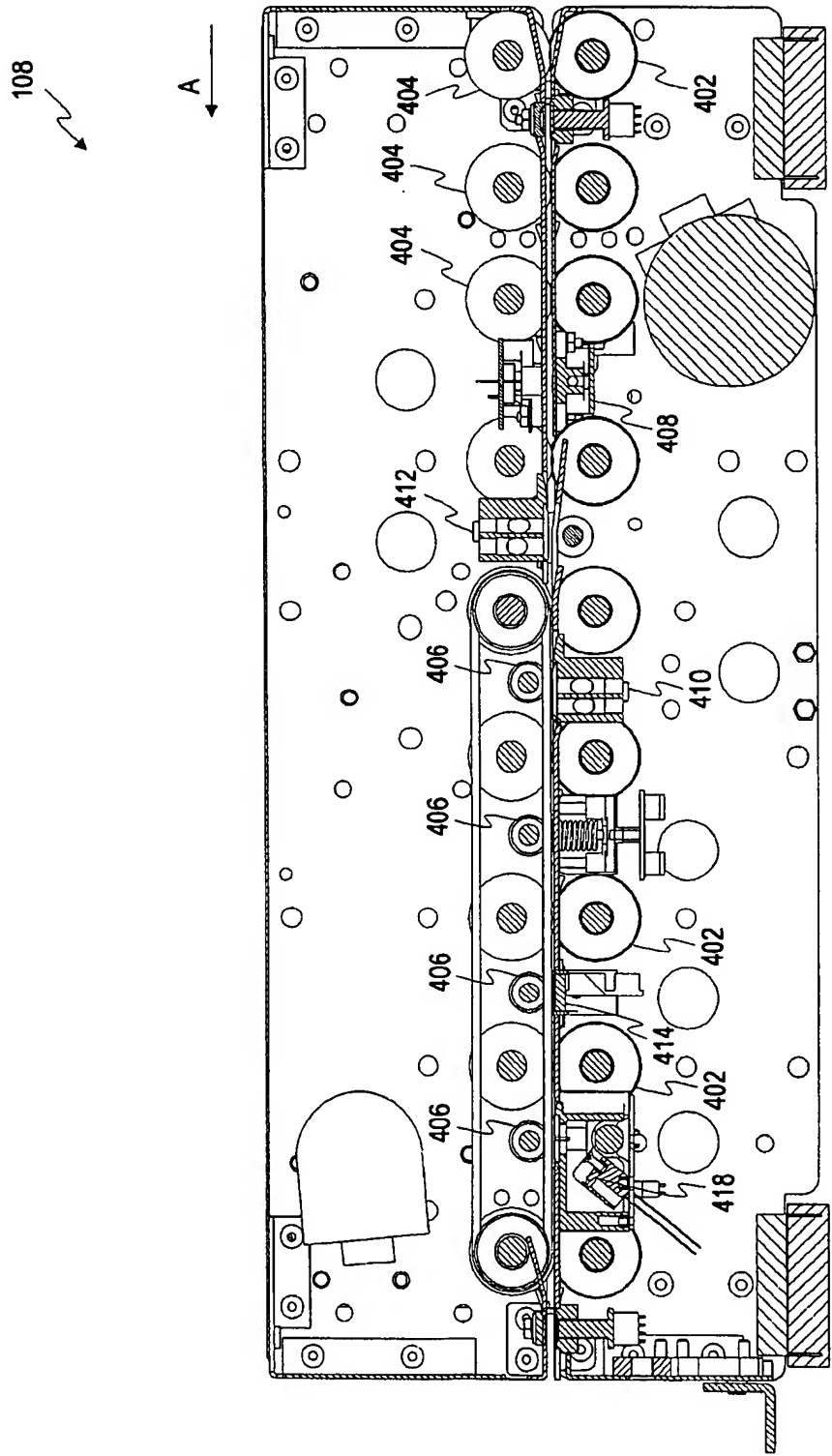


FIG. 2b

FIG. 3a

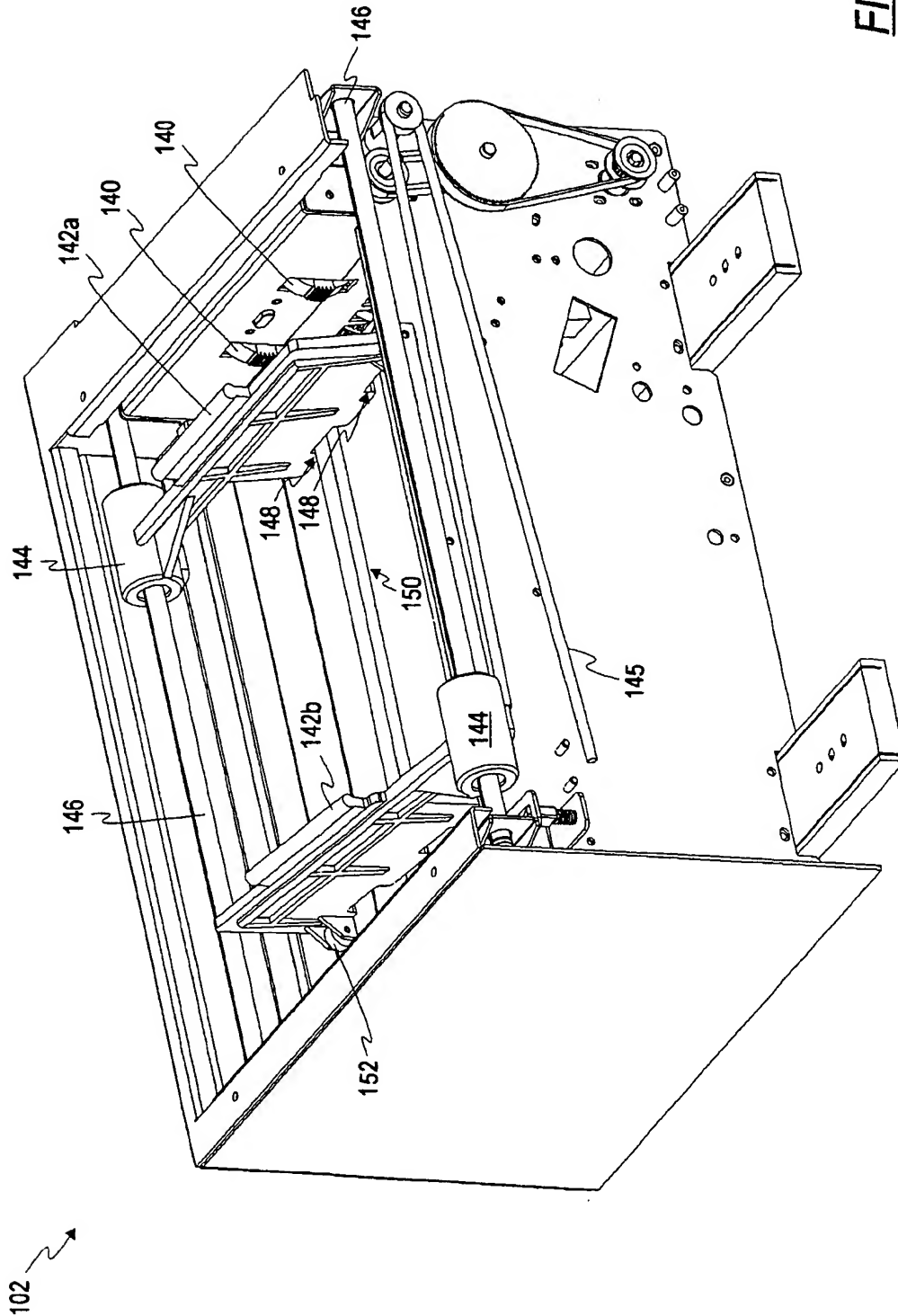


FIG. 3b

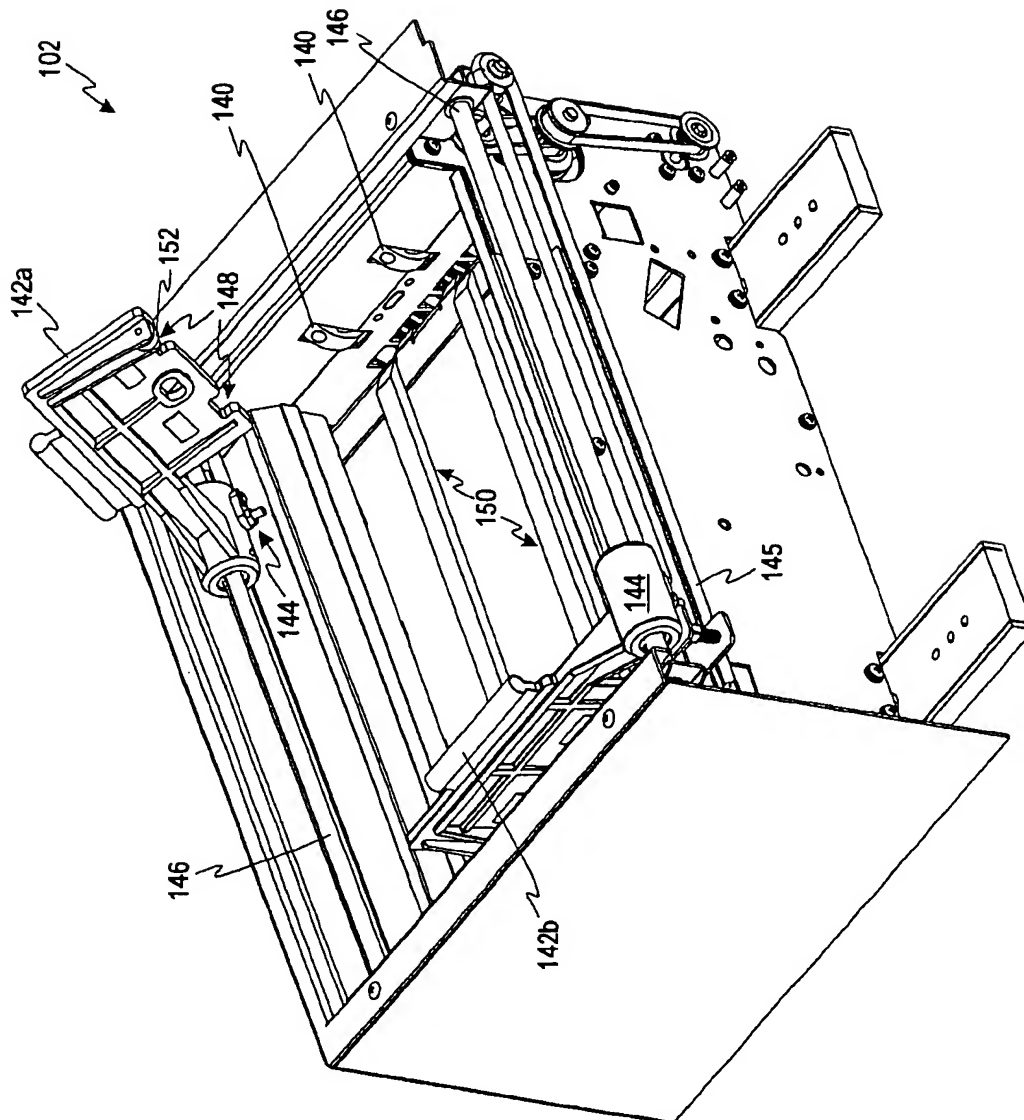
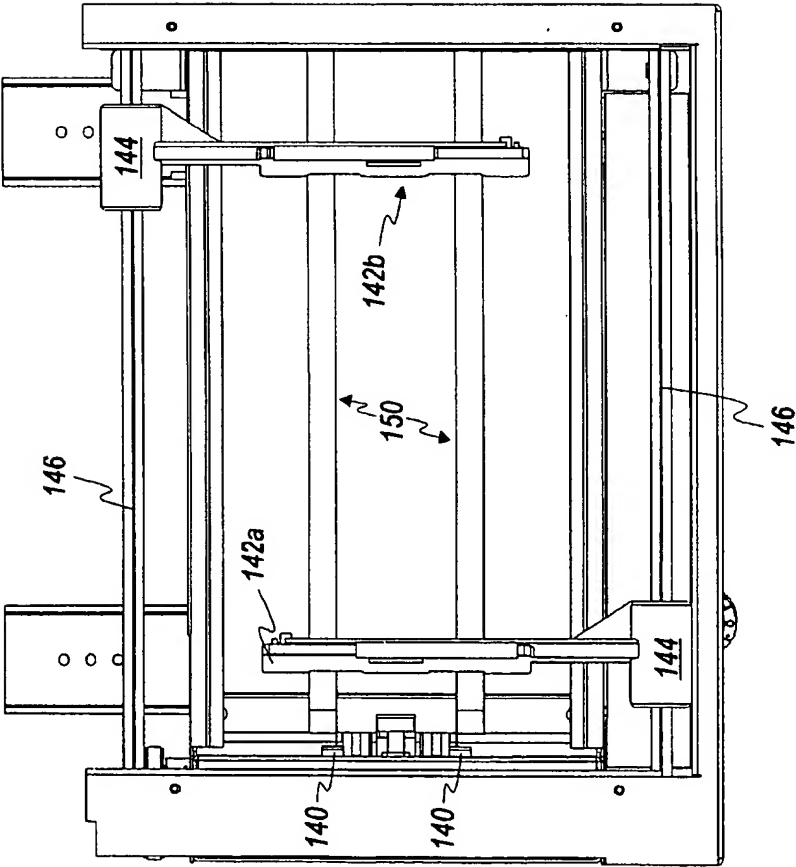




FIG. 3c

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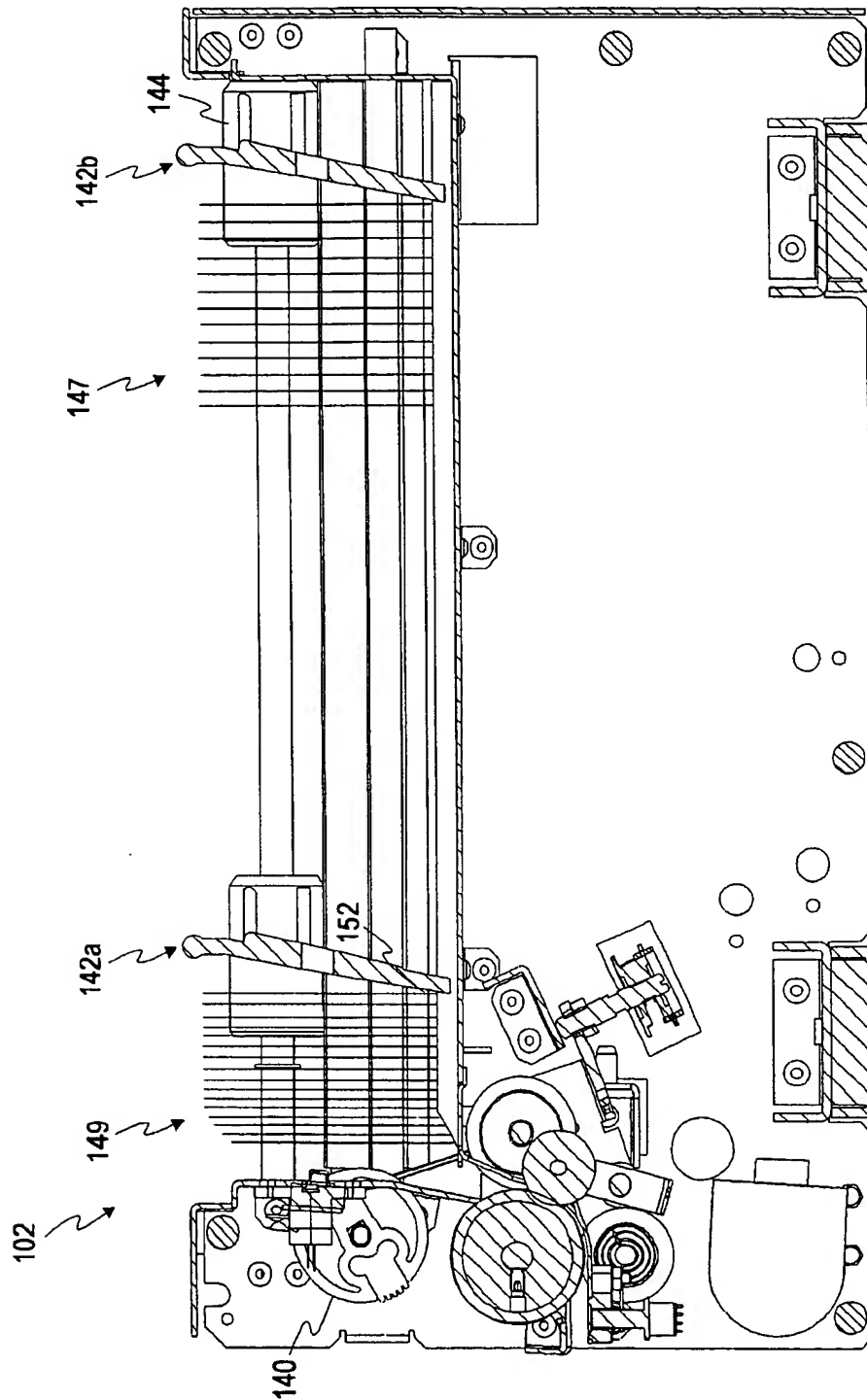
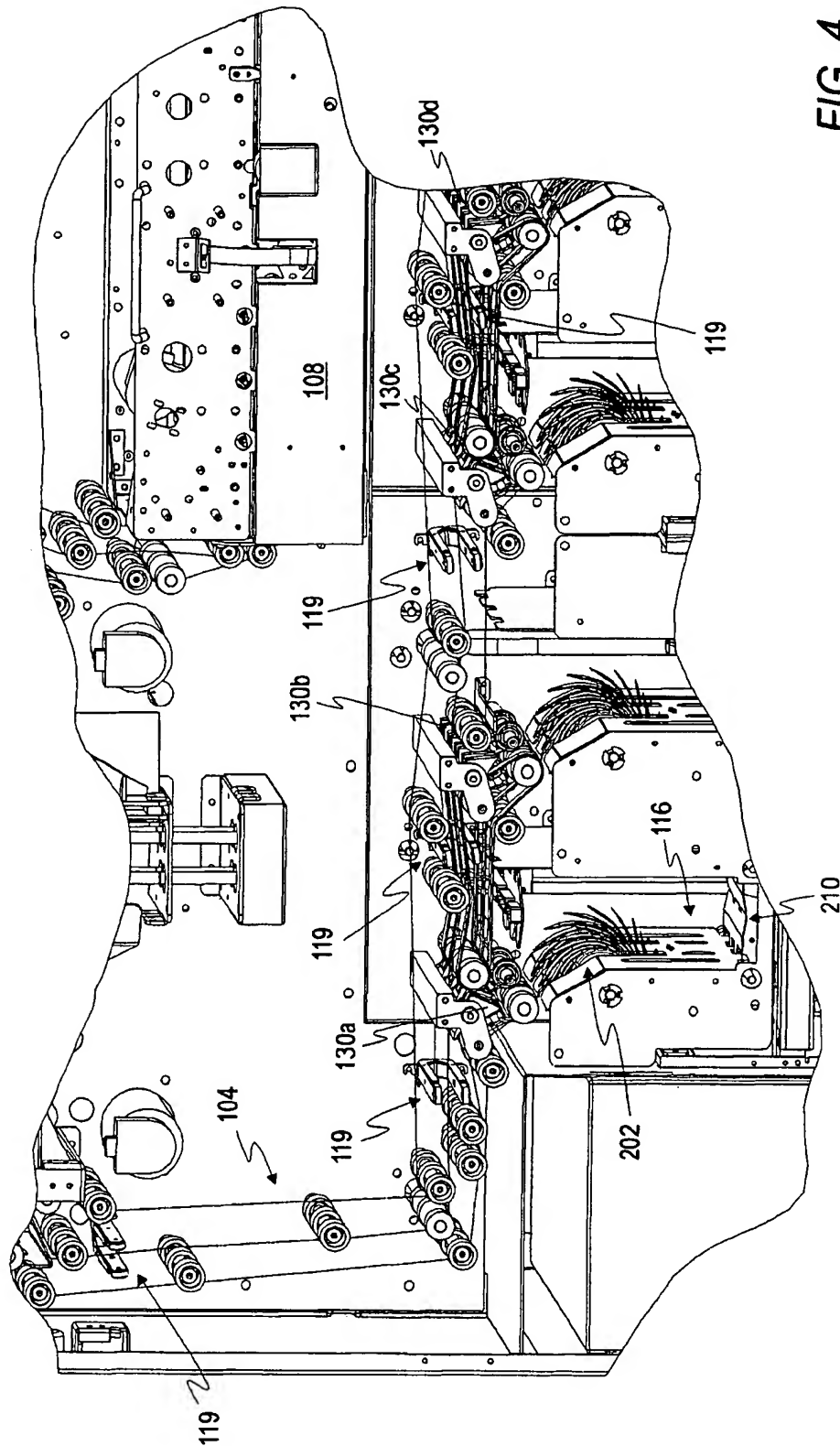


FIG. 3d



**FIG. 4**

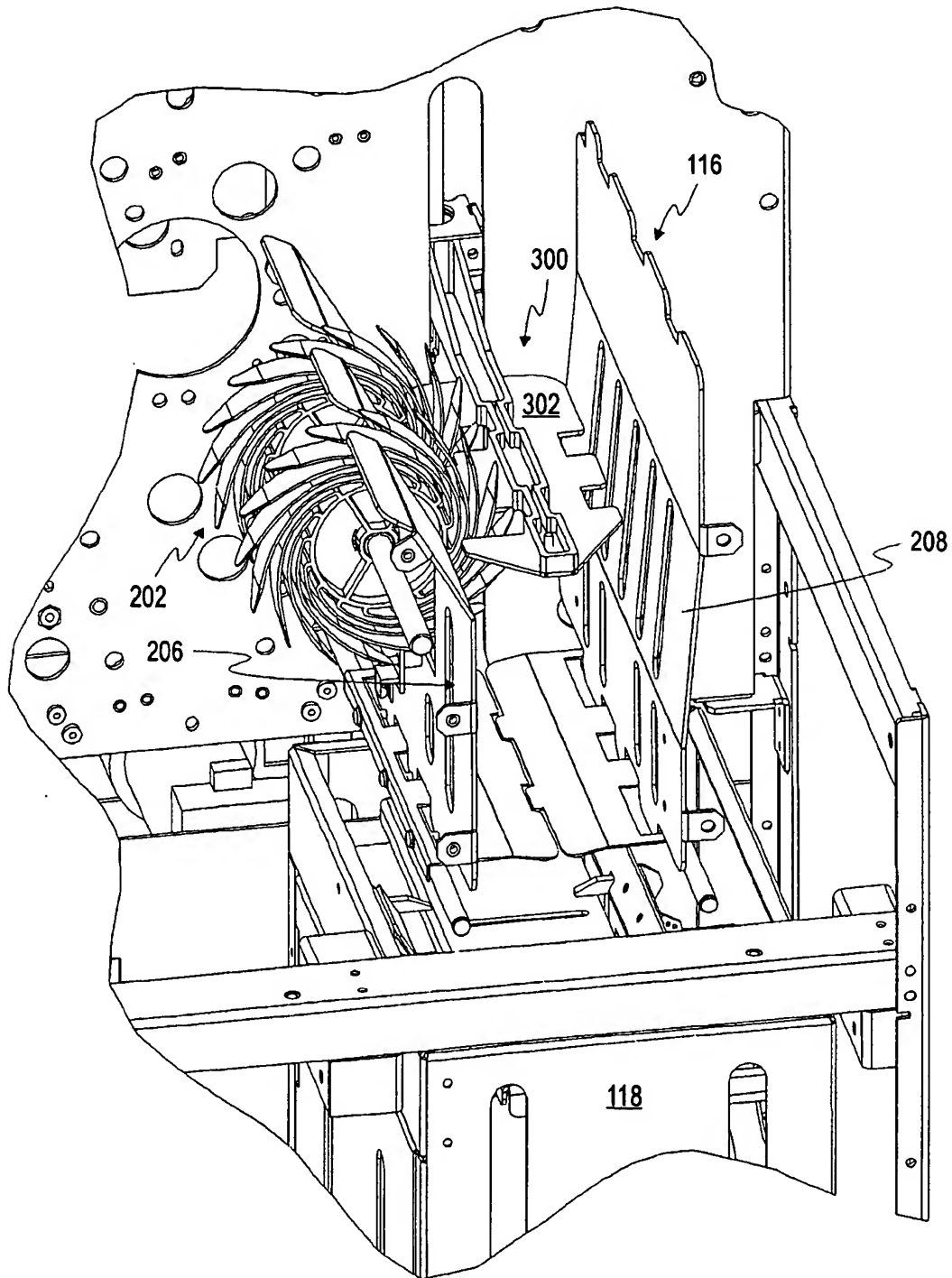
**FIG. 5**

FIG. 6

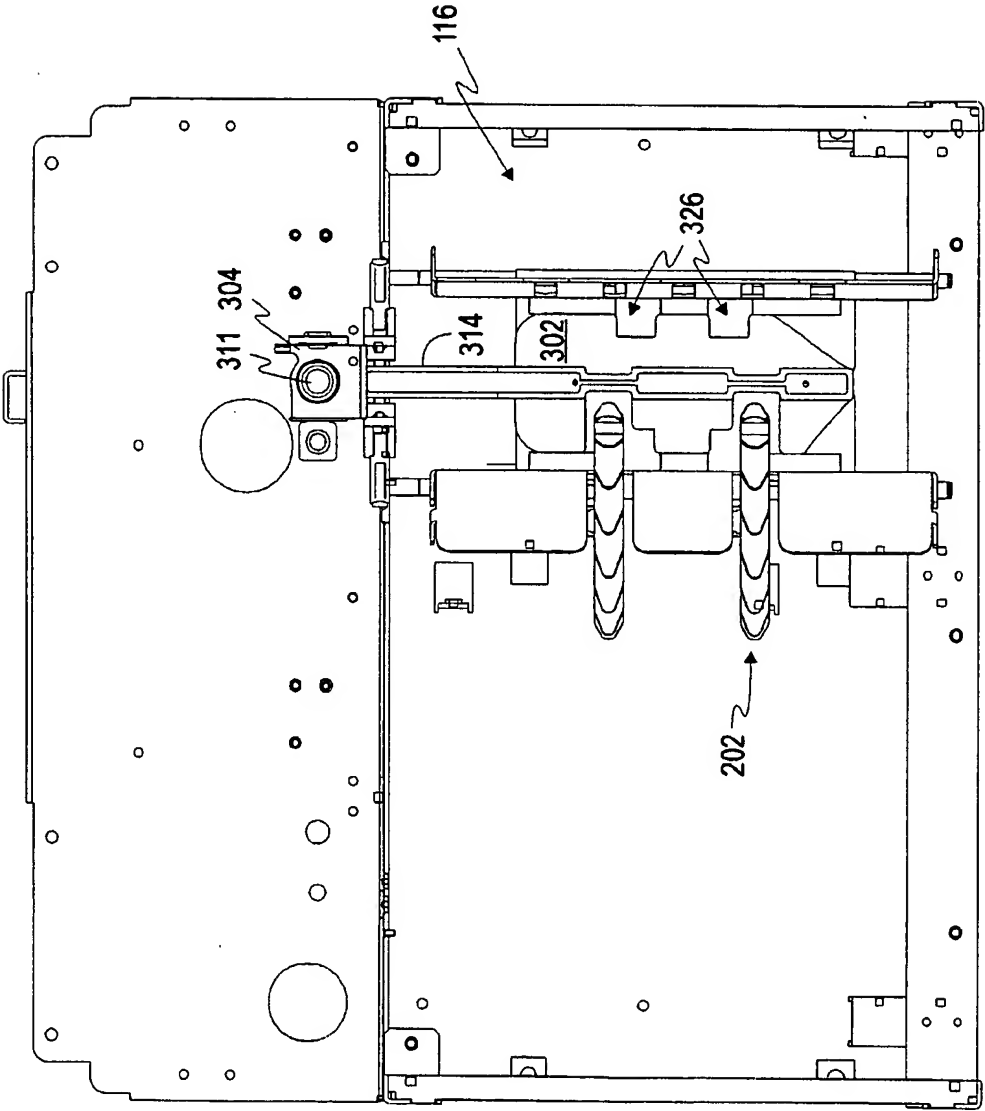


FIG. 7

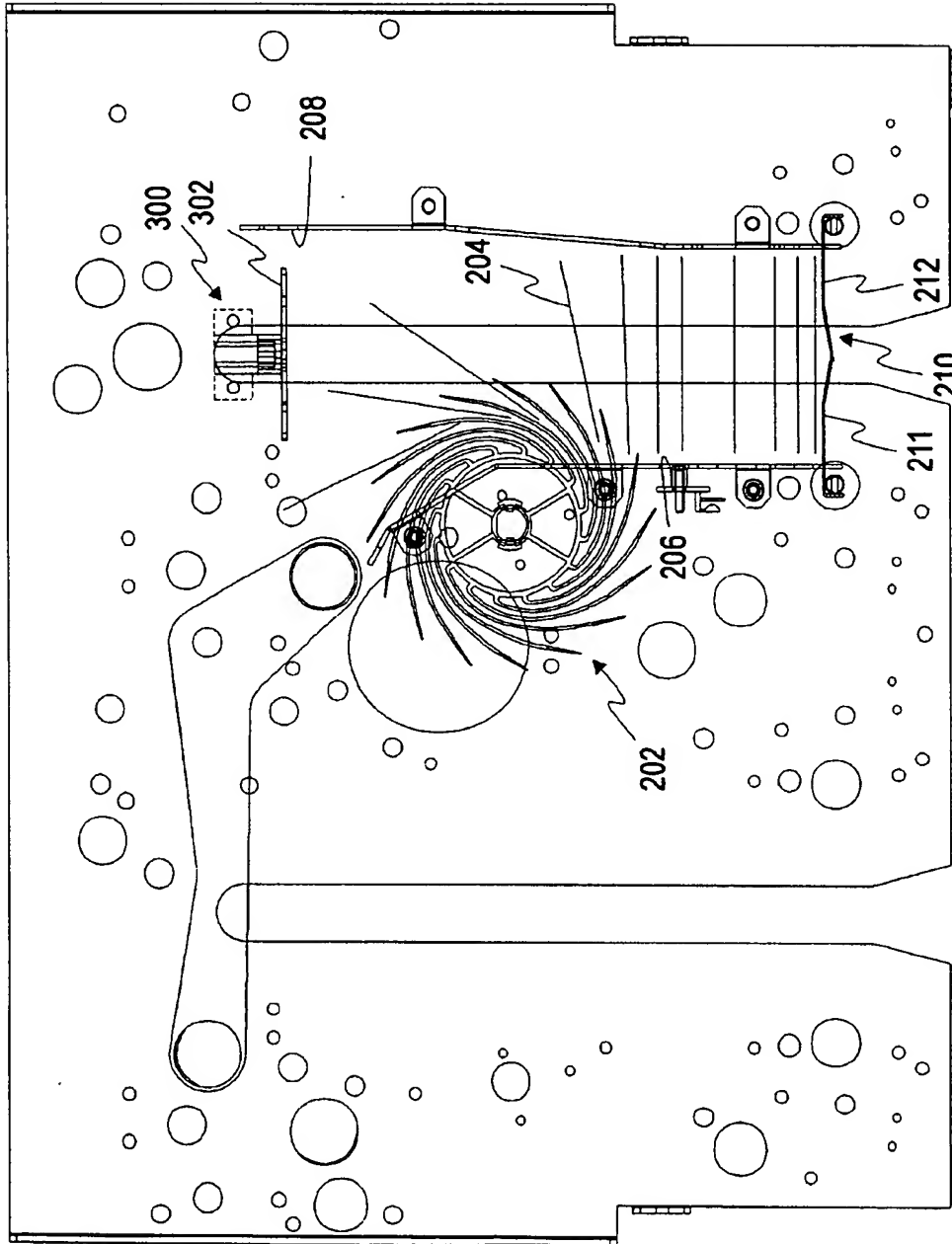
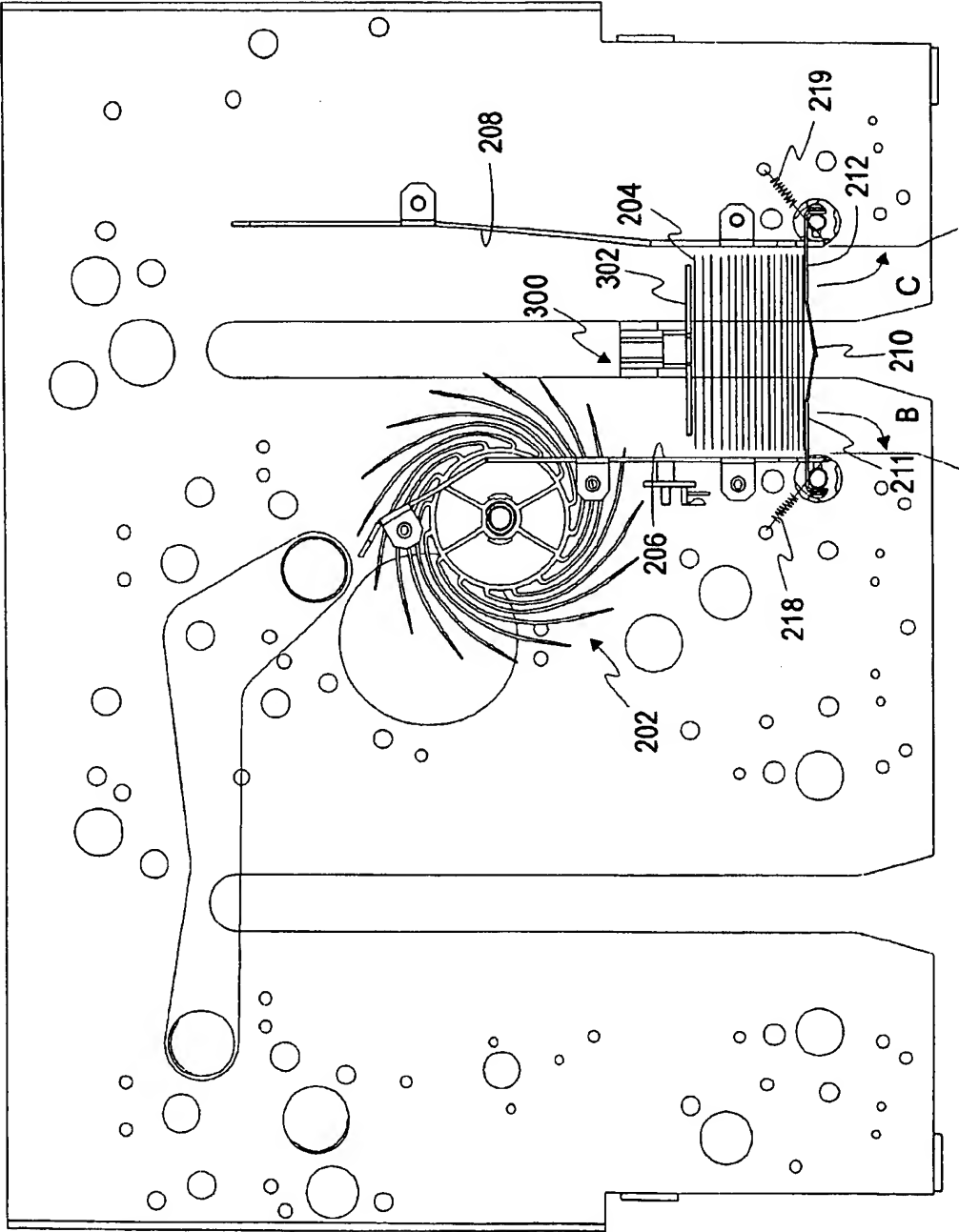


FIG. 8



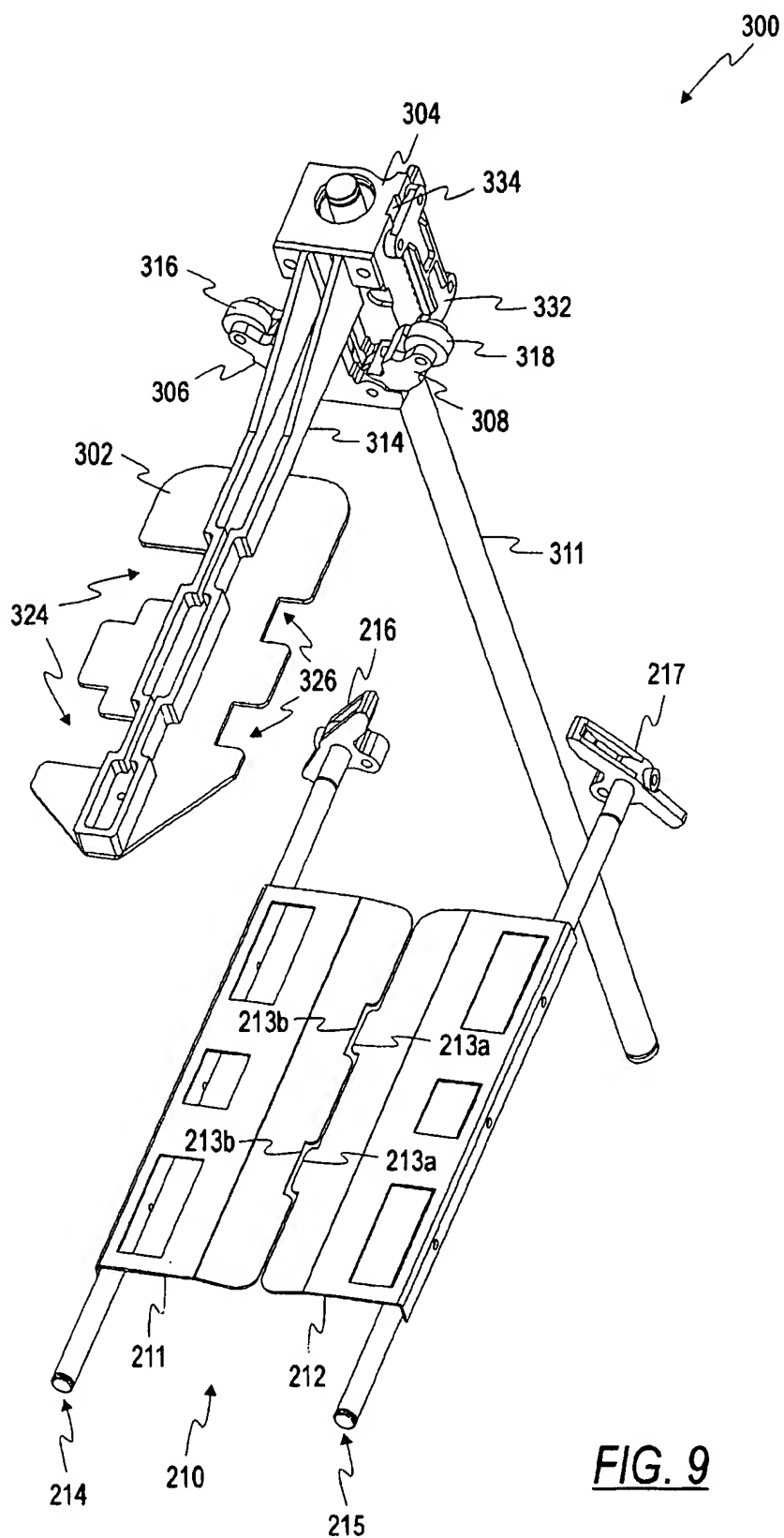
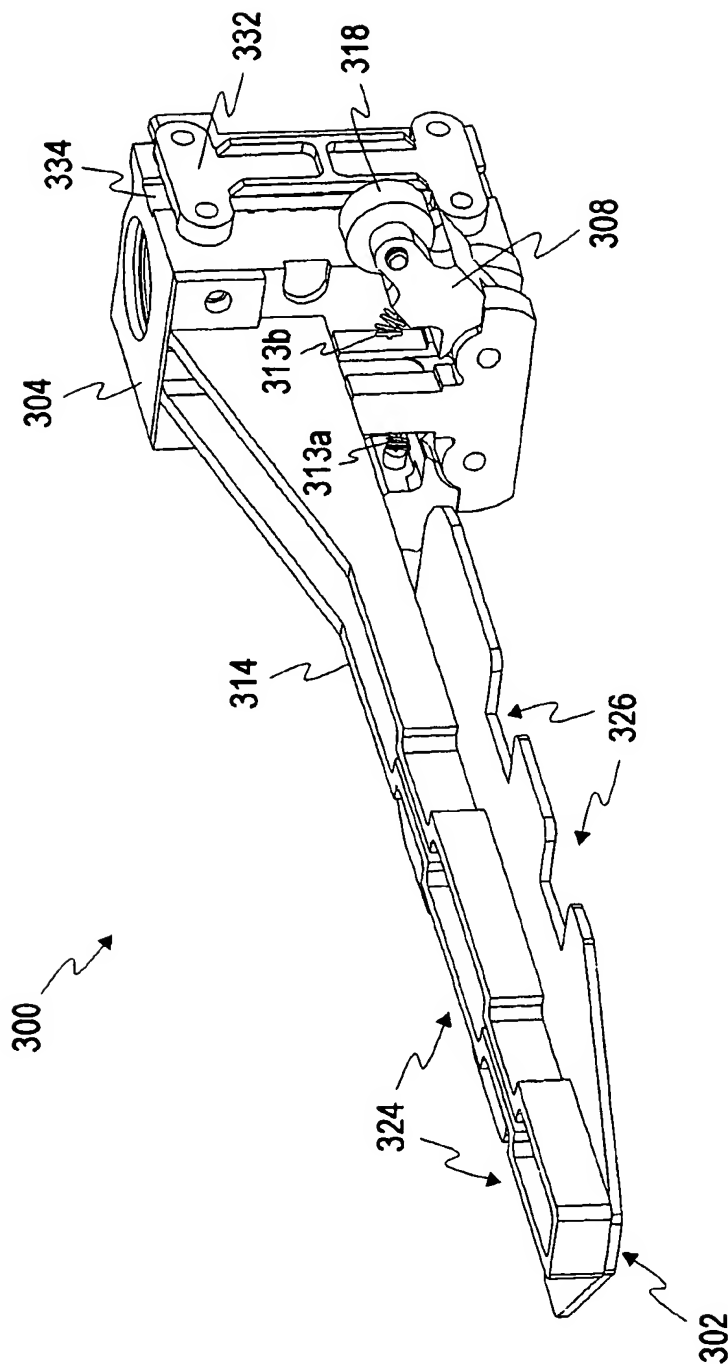
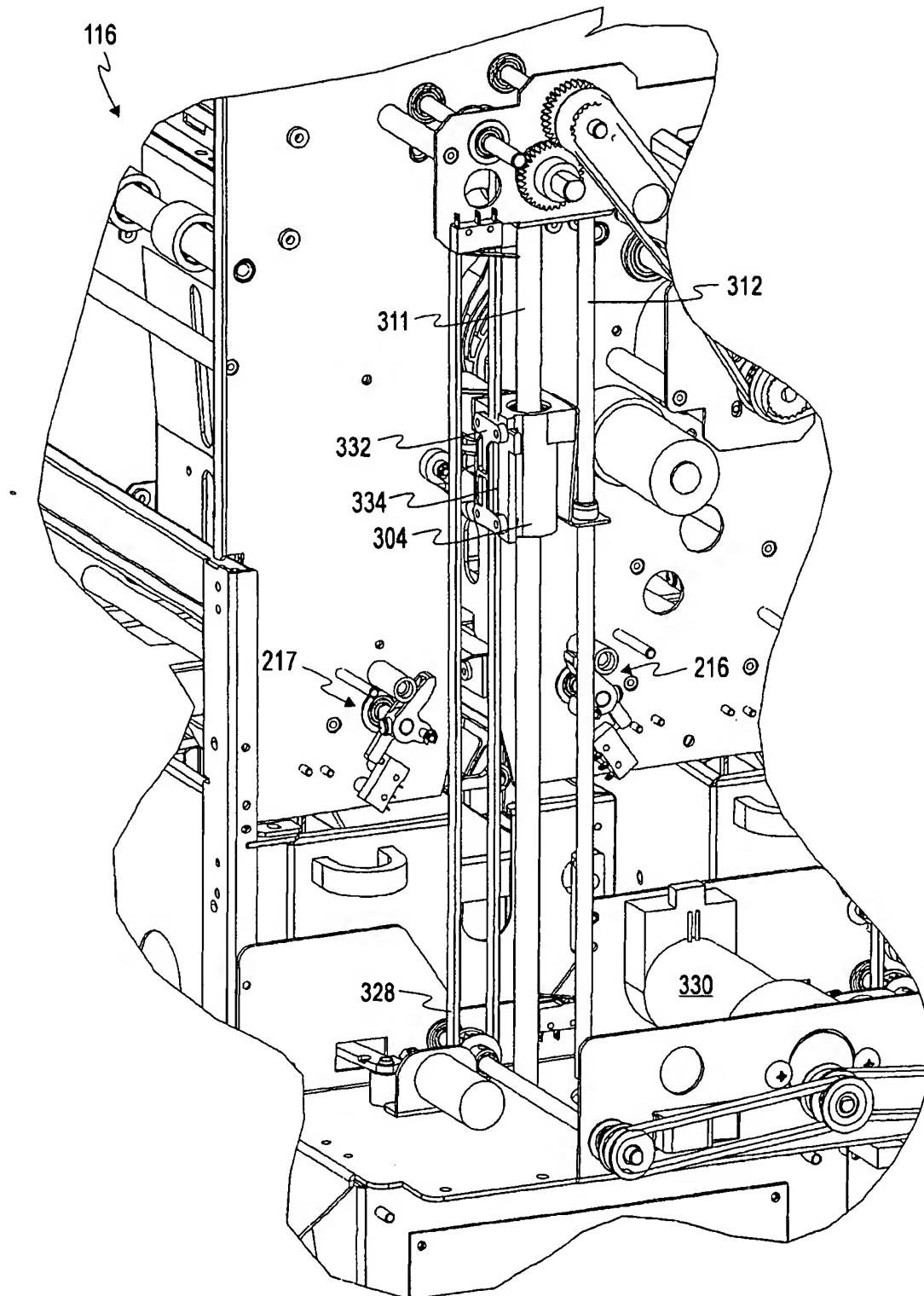
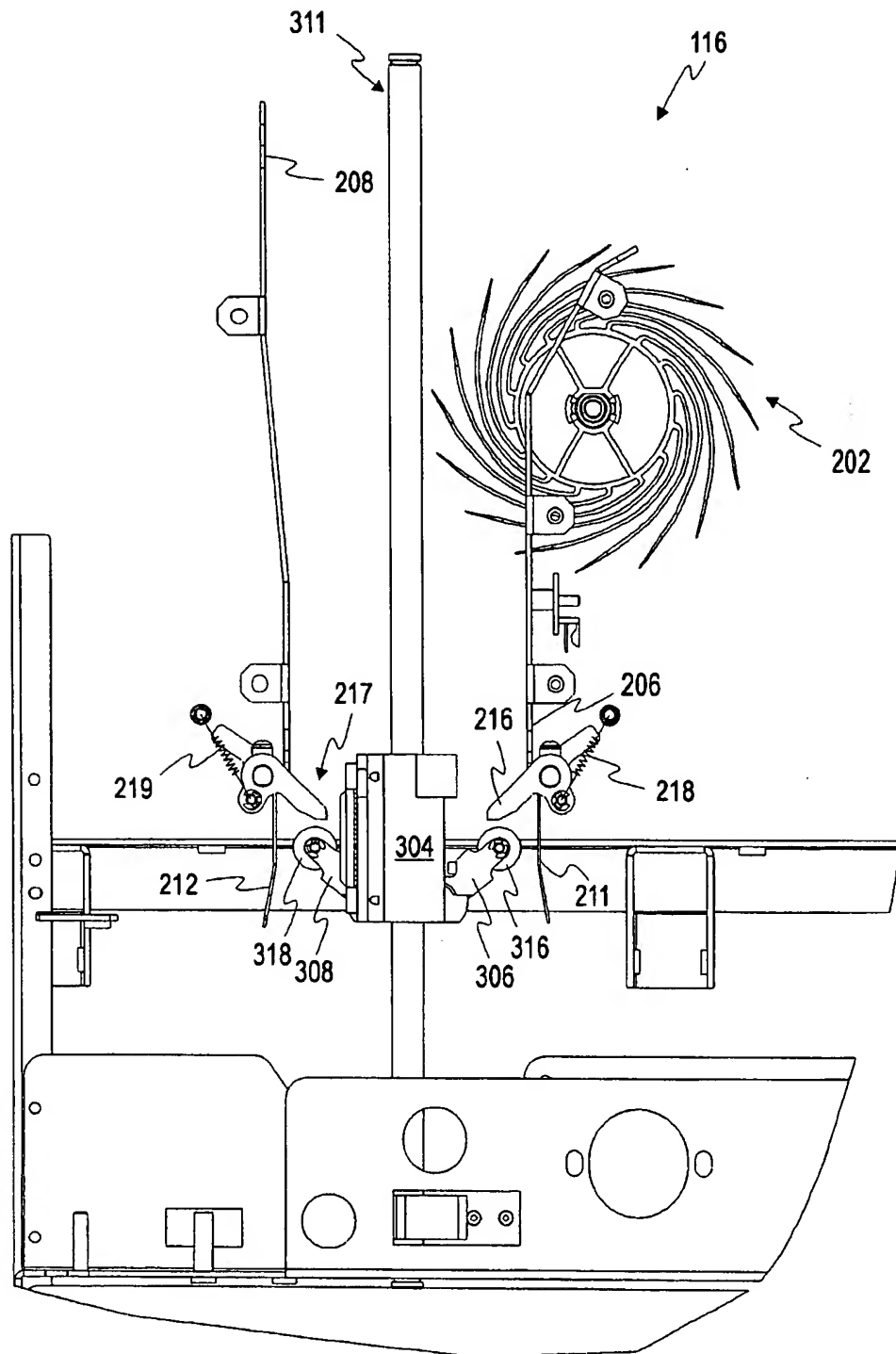


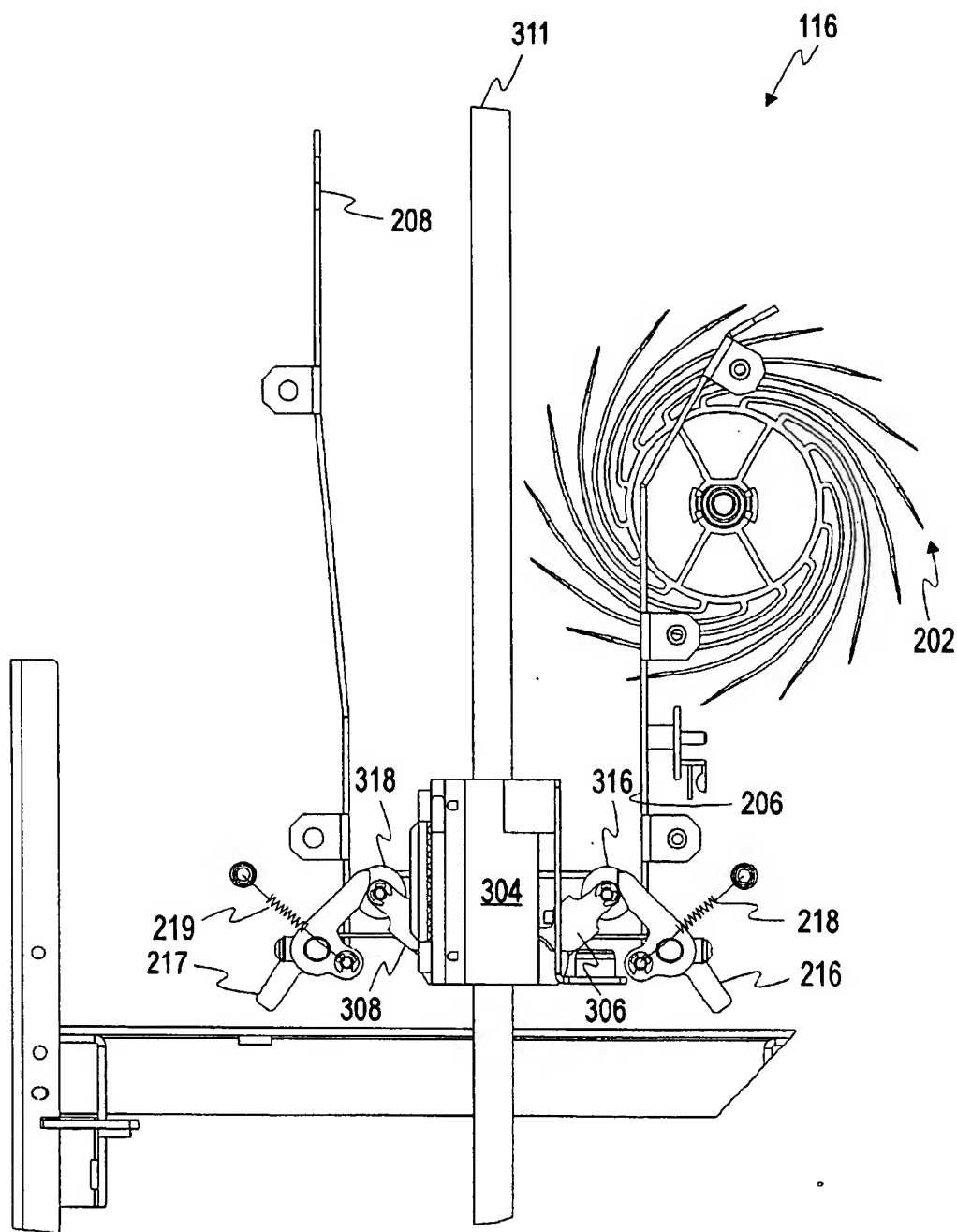


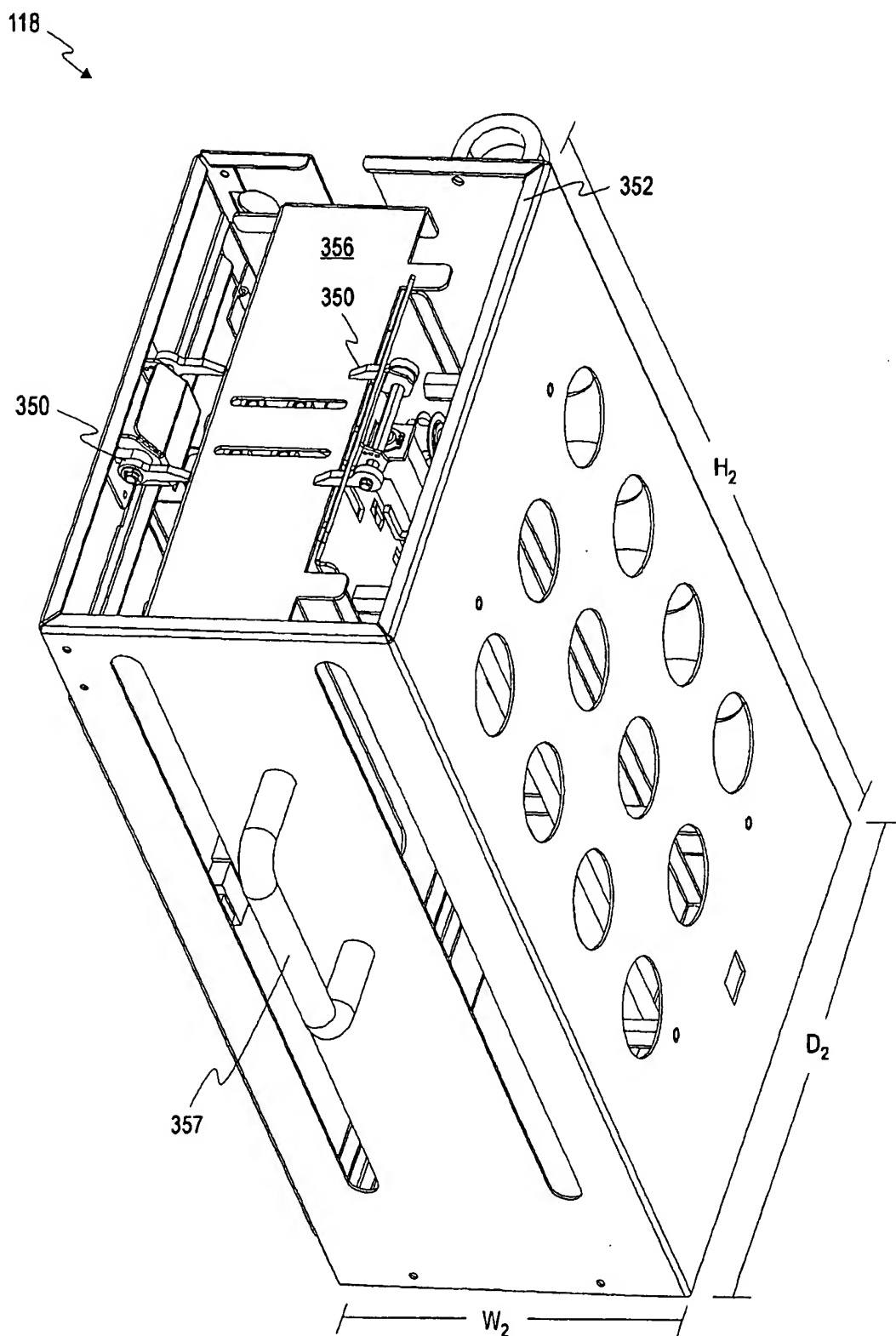
FIG. 10



**FIG. 11**

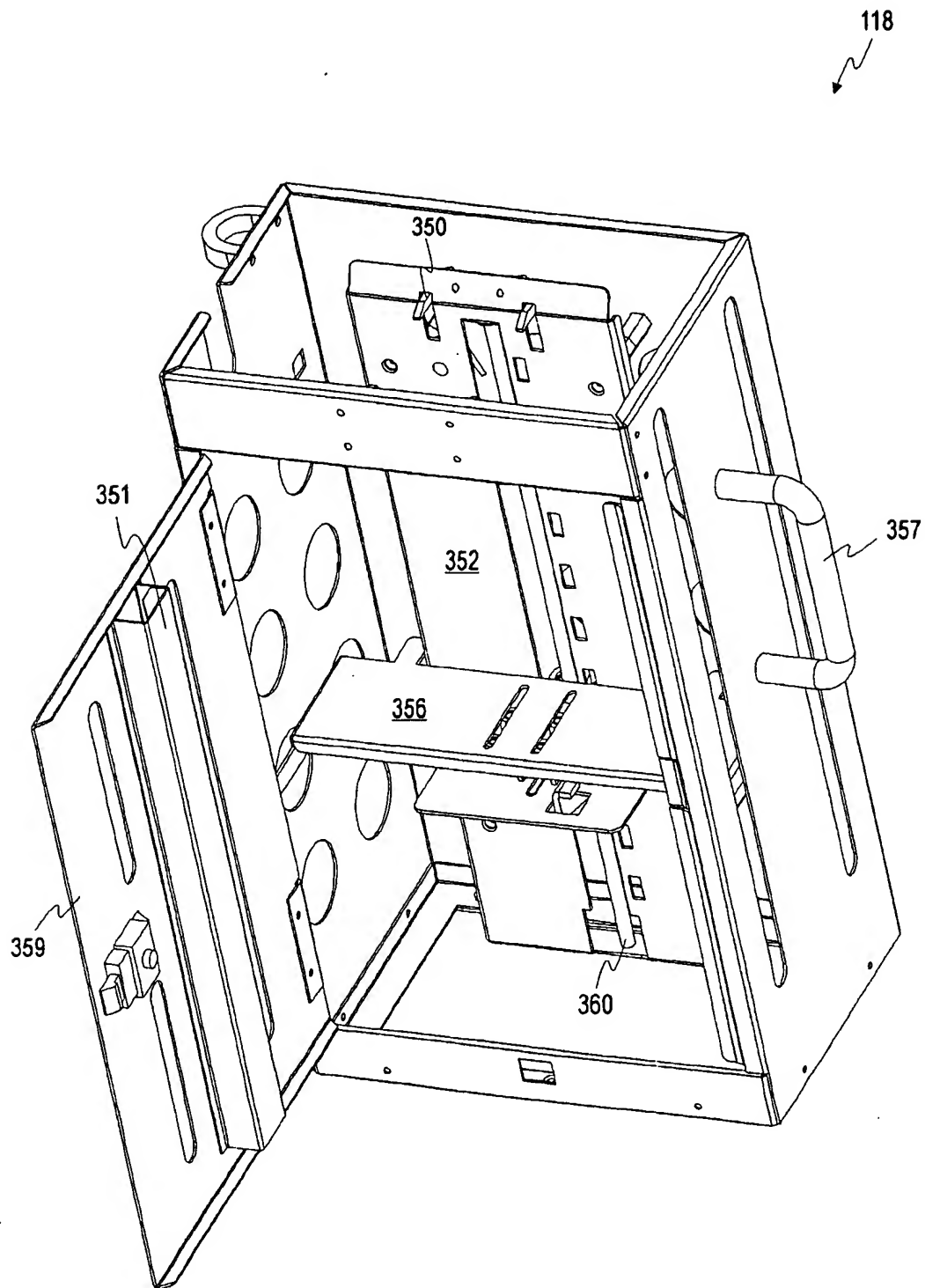
**FIG. 12**

**FIG. 13**



**FIG. 14**



FIG. 16

118

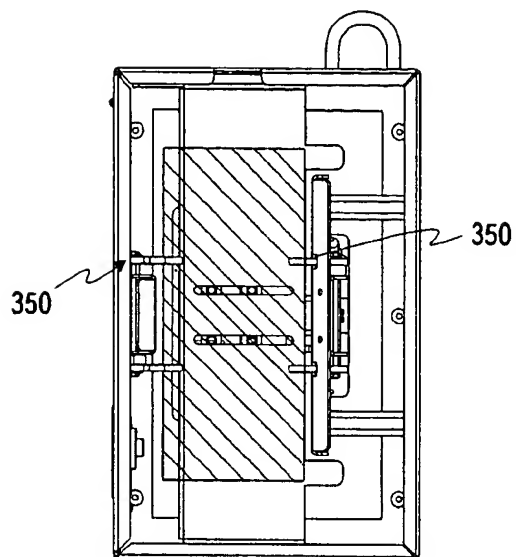


FIG. 17a

118

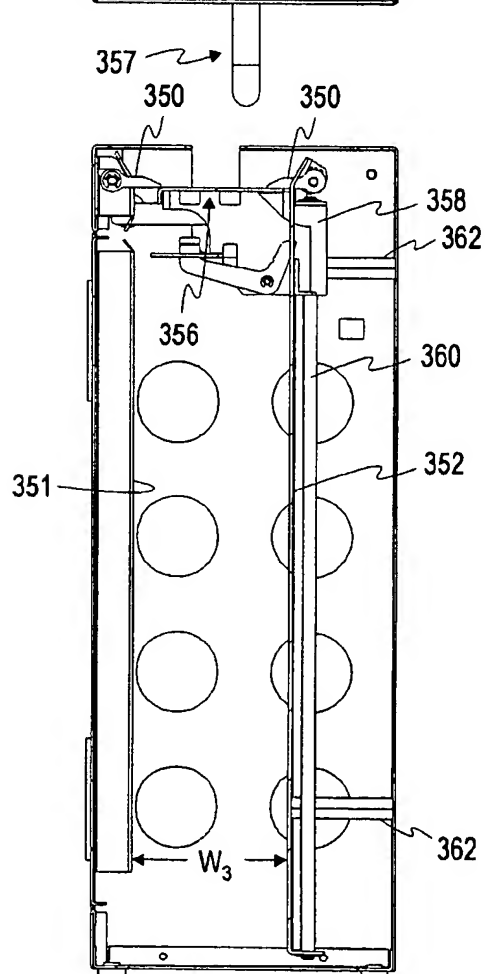


FIG. 17b



118 ↘

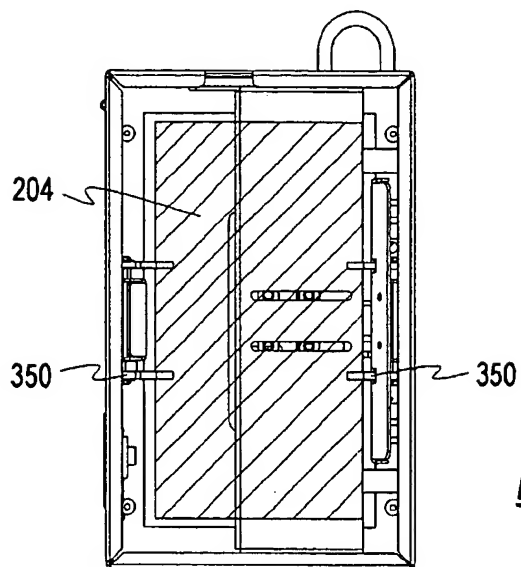


FIG. 18a

118 ↘

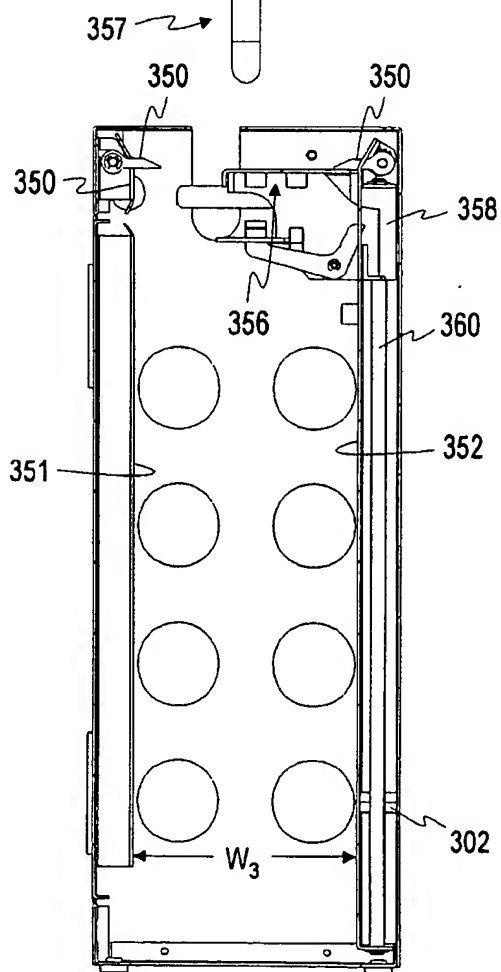
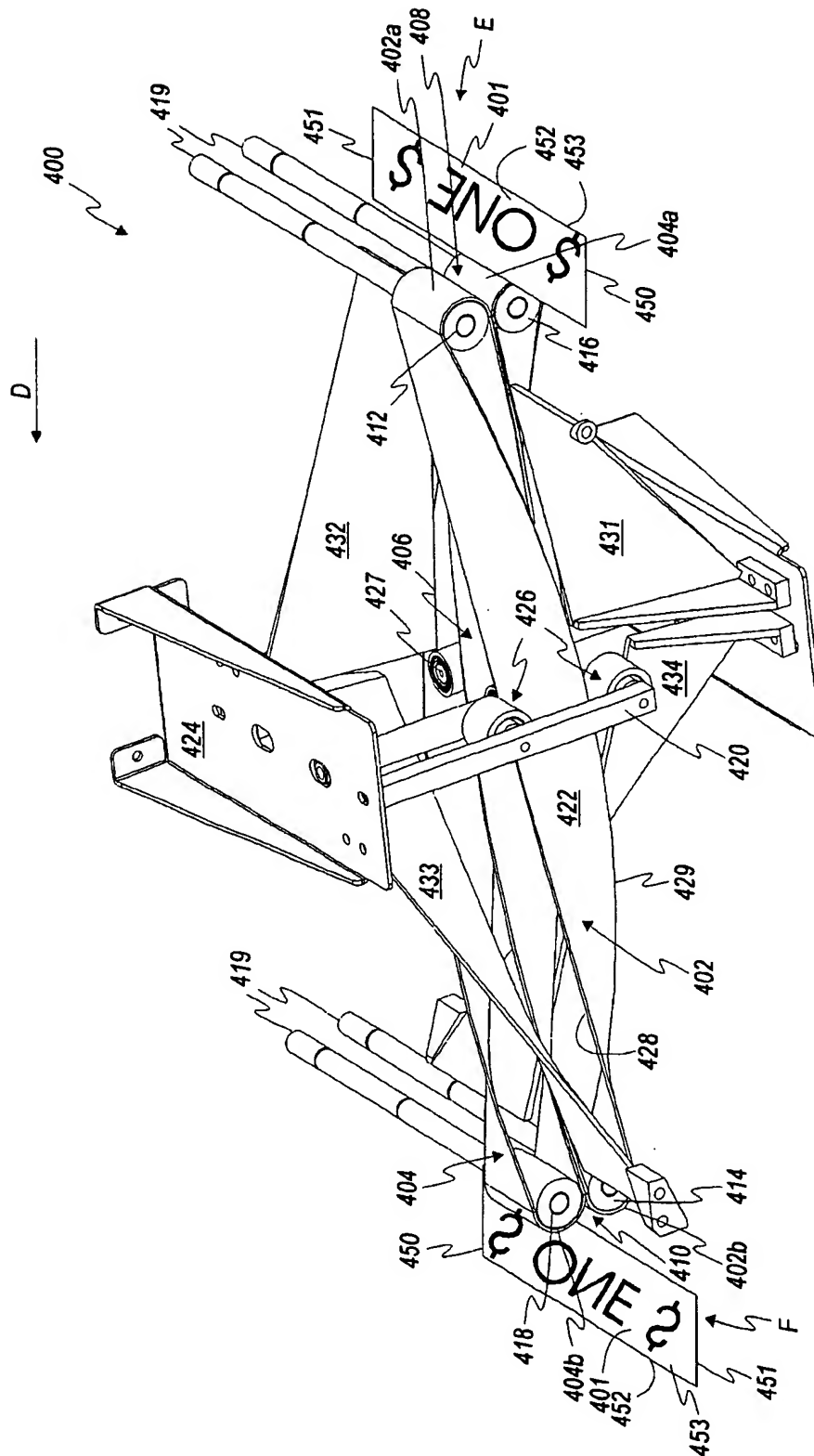


FIG. 18b

FIG. 19



**FIG. 20**

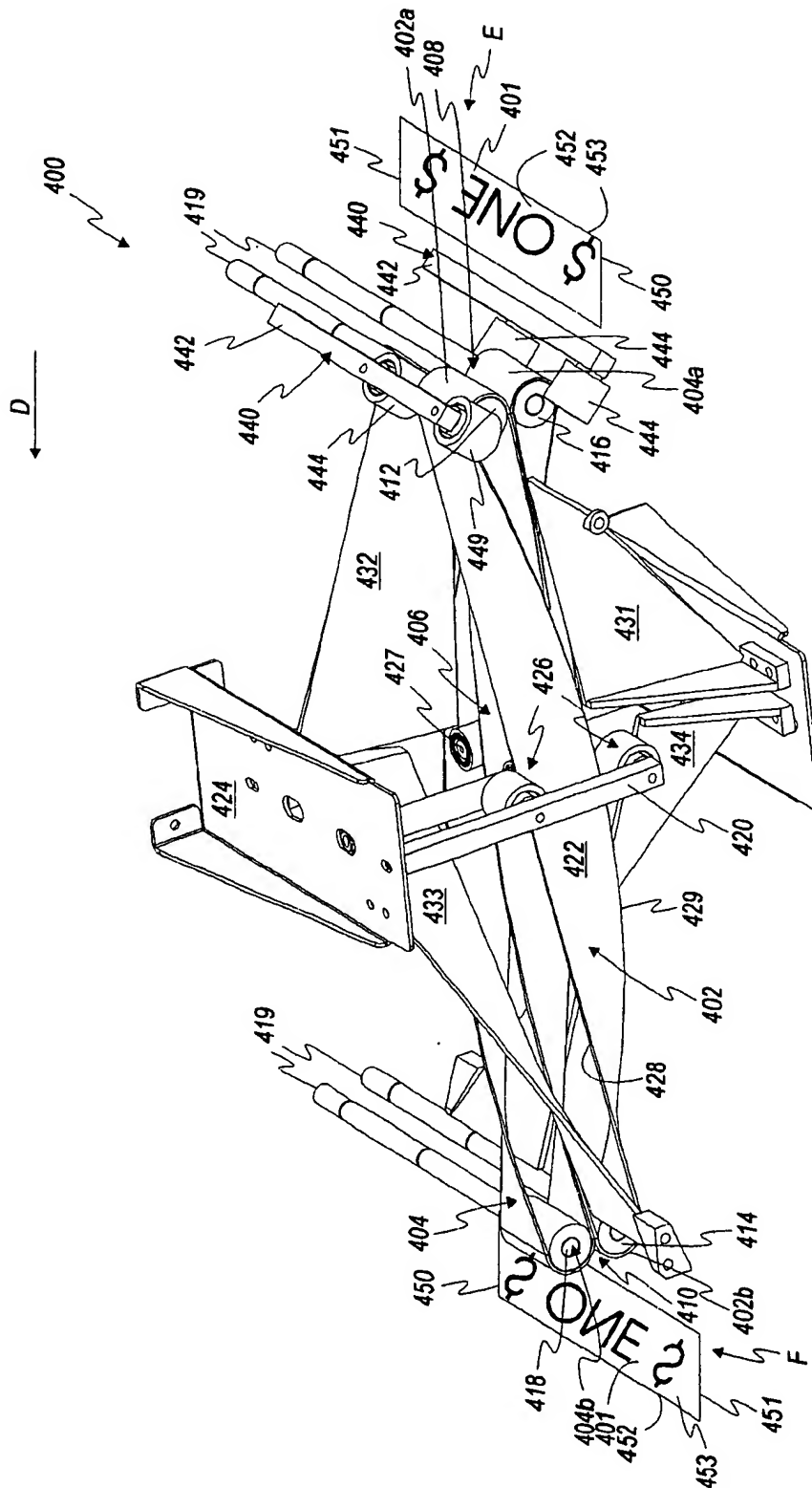


FIG. 21

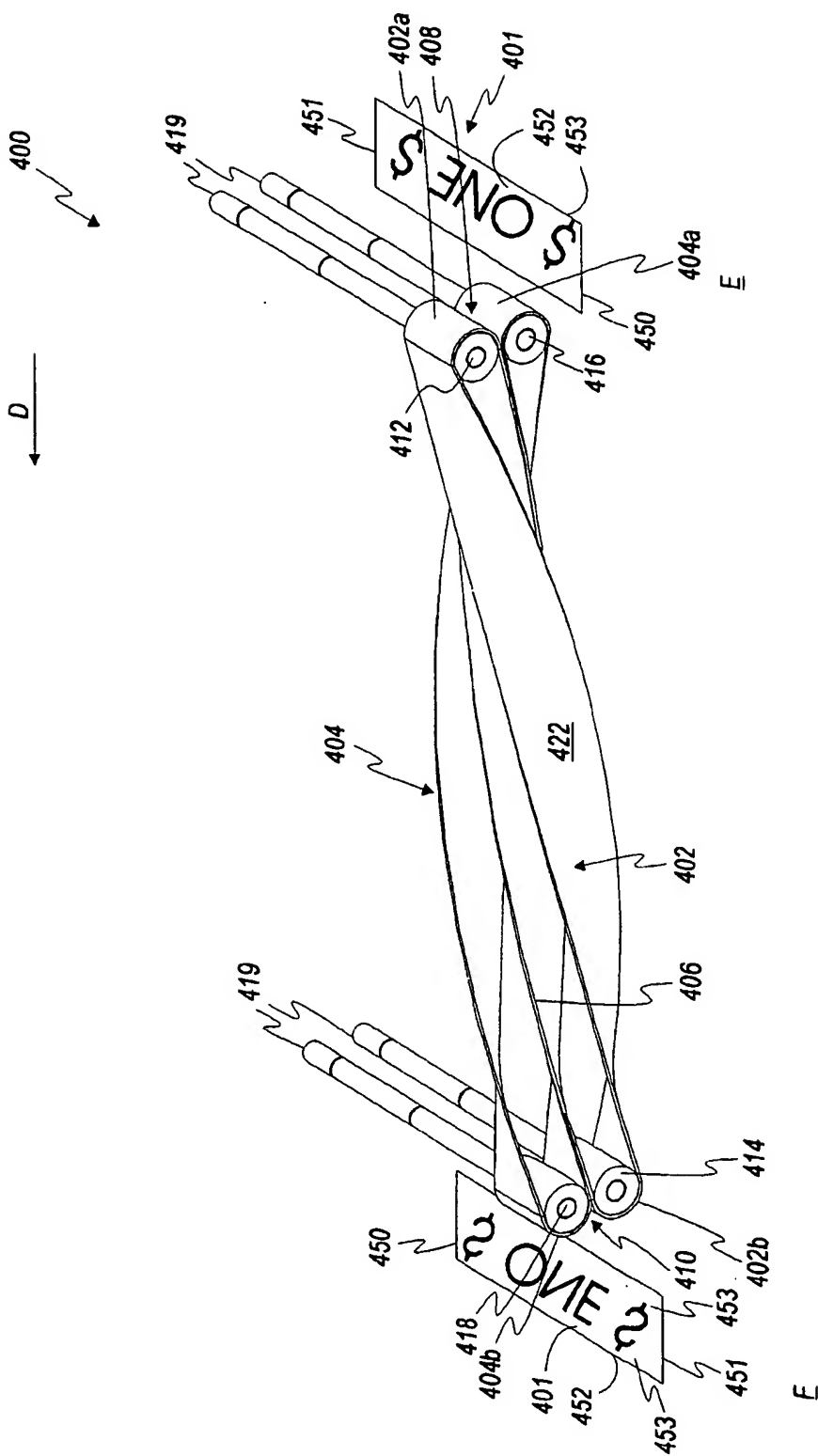
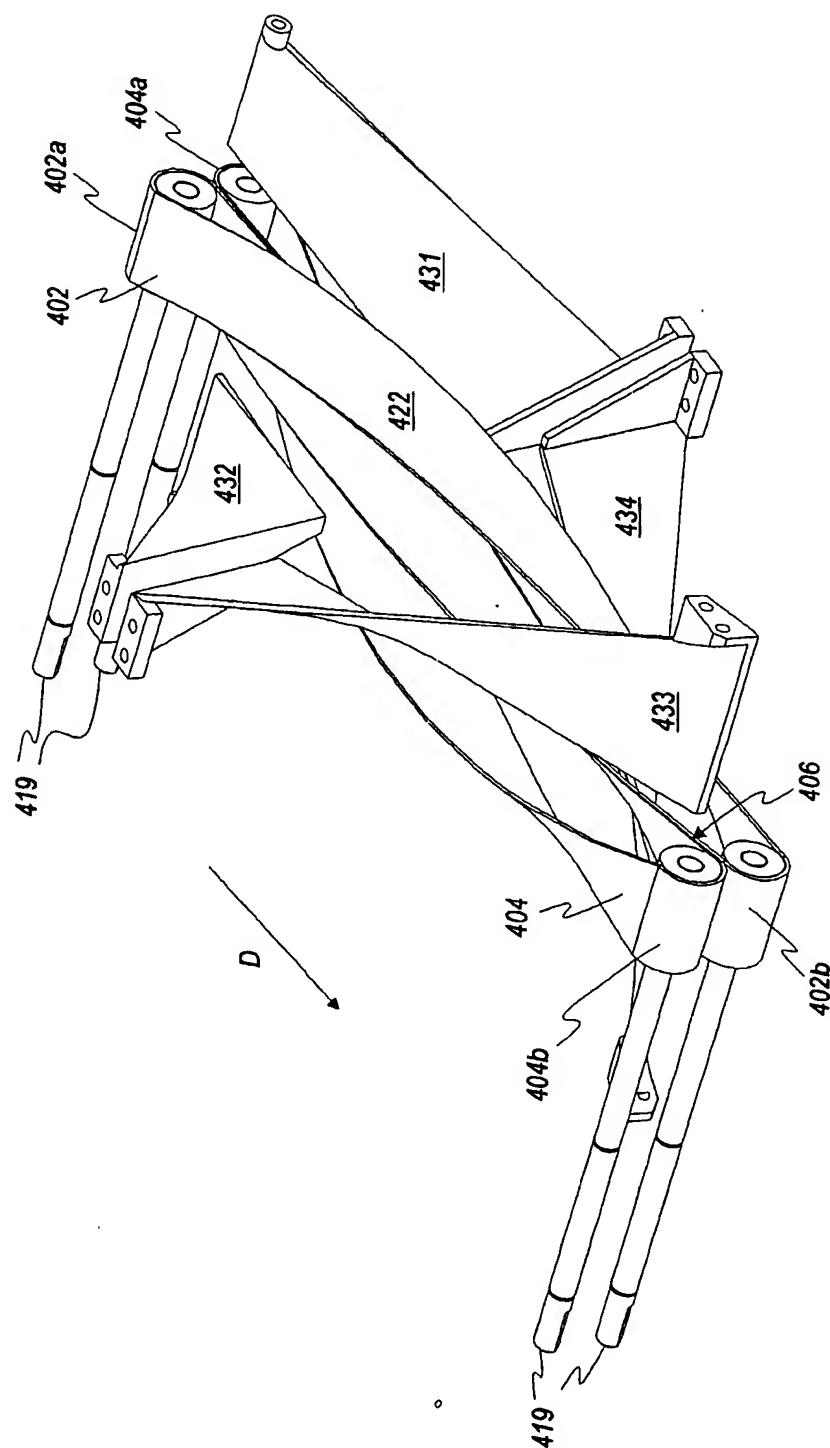
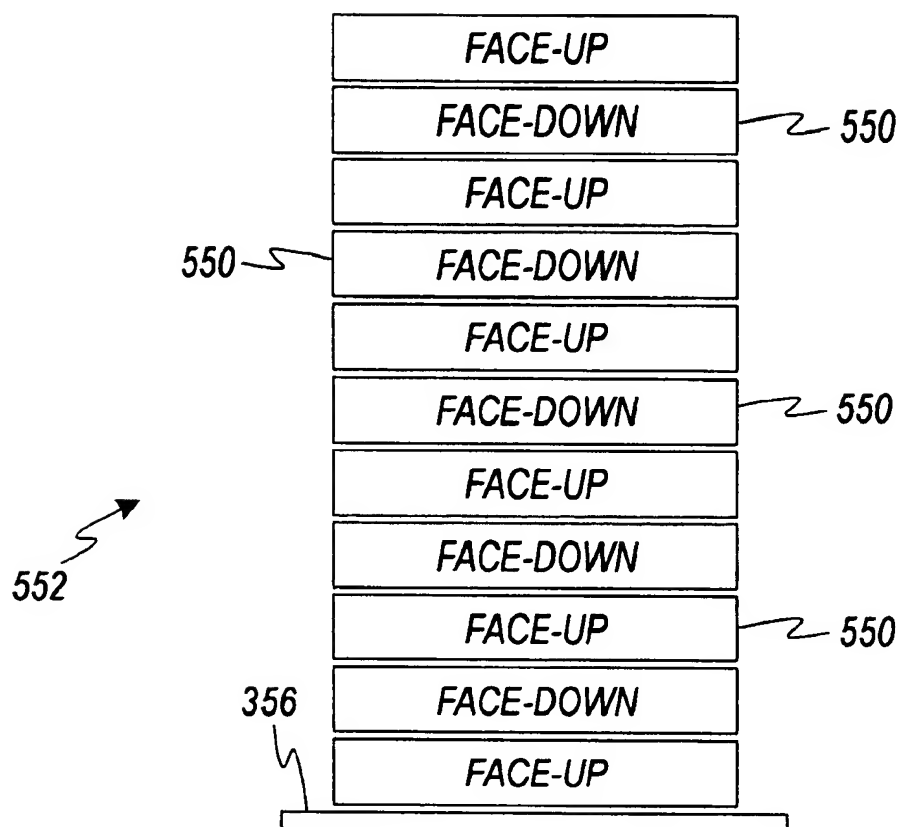


FIG. 22



FIG. 23

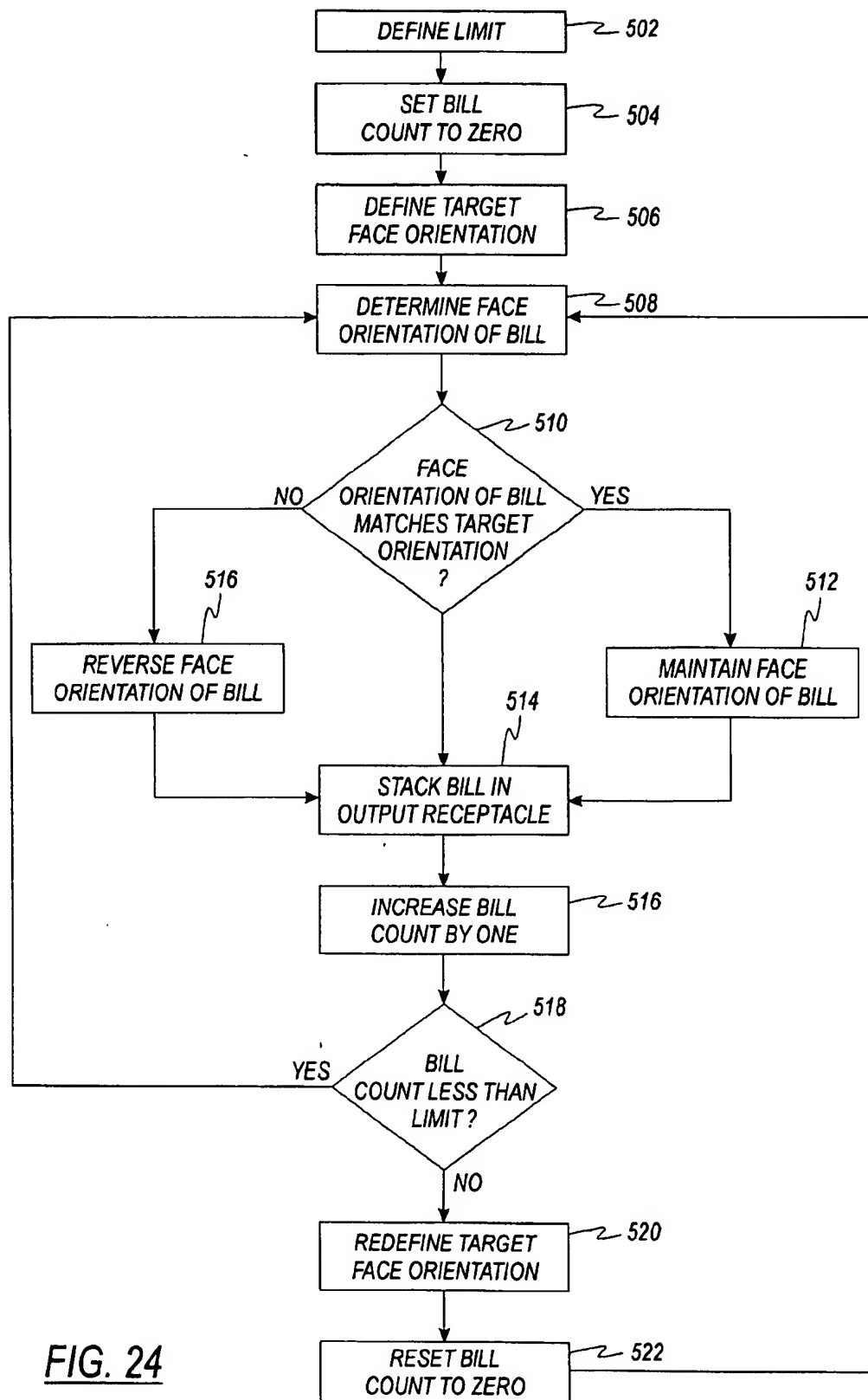


FIG. 24

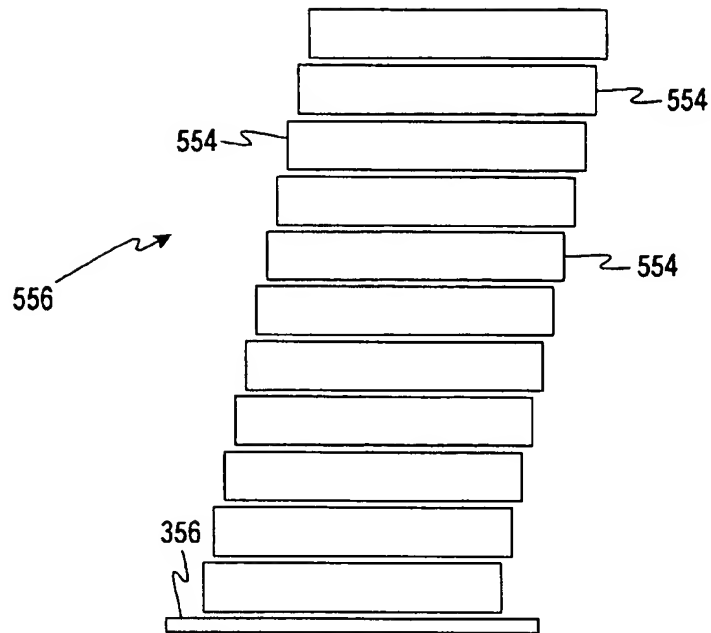


FIG. 25a

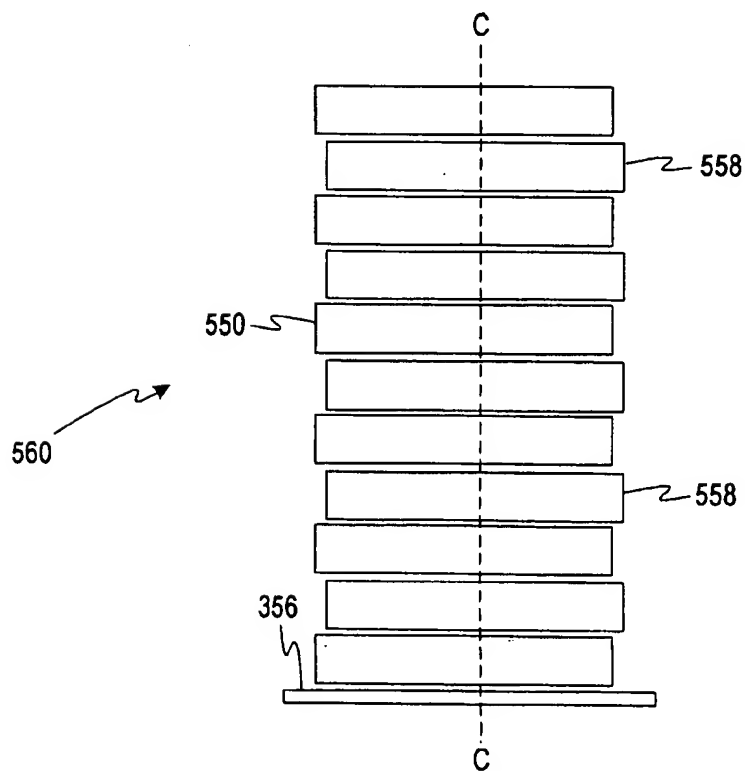


FIG. 25b



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# METHOD OF CREATING IDENTIFIABLE SMALLER STACKS OF CURRENCY BILLS WITHIN A LARGER STACK OF CURRENCY BILLS

## FIELD OF THE INVENTION

The present invention relates generally to the field of currency handling systems and, more particularly, to a method and apparatus for creating identifiable smaller stacks of currency bills within a larger stack of currency bills using a currency handling device.

## BACKGROUND OF THE INVENTION

A variety of techniques and apparatuses have been used to satisfy the requirements of automated currency handling machines. As businesses and banks grow, these businesses are experiencing a greater volume of paper currency. These businesses are continually requiring not only that their currency be processed more quickly but, also, processed with more options in a less expensive manner. At the upper end of sophistication in this area of technology are machines that are capable of rapidly identifying, discriminating, and counting multiple currency denominations and then sorting the currency bills into a multitude of output compartments. Further, some of these high-end machines can segregate the processed bills into smaller batches and then bind each of the smaller batches with a paper strap. Many of these high-end machines are extremely large and expensive such that they are commonly found only in large institutions. These machines are not readily available to businesses which have monetary and space budgets, but still have the need to process large volumes of currency. Other high-end currency handling machines require their own climate controlled environment which may place even greater strains on businesses having monetary and space budgets.

Typically, in the handling of bulk currency, after the currency bills have been analyzed, denominated, authenticated, counted and/or otherwise processed, the currency bills are strapped. Bill strapping is a process whereby a stack of a specific number of bills of a single denomination are secured with a paper strap. For example, one dollar bills are segregated into stacks of one-hundred \$1 bills and then bound with a paper strap. Strapping facilitates the handling of currency by allowing the strapped stacks of bills to be counted rather than the individual currency bills. Traditionally, U.S. currency bills are strapped in one-hundred bill stacks.

The task of bill strapping can increase the amount of time required to process a given batch of currency. Some currency handling machines are able to segregate currency bills into individual denominations, then the operator must manually count the bills into smaller batches for strapping purposes. In other situations, a currency handling device may suspend operation after a predetermined number of bills of a given denomination have been delivered to an output receptacle at which time the operator can remove those bills from the output receptacle and bind the bills with a paper strap. However, this manner of strapping can increase the time required to process a batch of currency bills. Higher end currency processing machines are capable of strapping bills. However, there is an increased cost associated with these higher end machines.

## SUMMARY OF THE INVENTION

According to one embodiment of the present invention there is provided a method and device for identifying small

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stacks of currency bills within a larger stack of currency bills using a currency evaluation device. A batch of currency bills to be processed are received in an input receptacle and are transported from the input receptacle, one at a time, past an evaluating unit to at least one output receptacle. The evaluating unit determines information concerning each of the bills including the face orientation of each of the bills. Next it is determined whether the face orientation of each of the bills matches a target face orientation. If the face orientation of a bill matches the target orientation, the face orientation of that bill is maintained. If the face orientation of a bill fails to match the target orientation, the face orientation of that bill is reversed with a bill facing mechanism. Each of the bills are then stacked in the output receptacle. After a predetermined number of bills having a common face orientation are stacked in the output receptacle, the target face orientation is redefined. The bills continue to be processed in this manner until each of the bills are transported from the input receptacle.

The above summary of the present invention is not intended to represent each embodiment, or every aspect, of the present invention. Additional features and benefits of the present invention will become apparent from the detail description, figures, and claim set forth below.

## BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the invention will become apparent upon reading the following detailed description in conjunction with the drawings in which:

FIG. 1a is a perspective view of a document handling device according to one embodiment of the invention;

FIG. 1b is a front view of a document handling device according to one embodiment of the invention;

FIG. 2a is a perspective view of an evaluation region according to one embodiment of the document handling device of the present invention;

FIG. 2b is a side view of an evaluation region according to one embodiment of the document handling device of the present invention;

FIG. 3a is a perspective view of an input receptacle according to one embodiment of the document handling device of the present invention;

FIG. 3b is another perspective view of an input receptacle according to one embodiment of the document handling device of the present invention;

FIG. 3c is a top view of an input receptacle according to one embodiment of the document handling device of the present invention;

FIG. 3d is a side view of an input receptacle according to one embodiment of the document handling device of the present invention;

FIG. 4 is a perspective view of a portion of a transportation mechanism according to one embodiment of the present invention;

FIG. 5 is a front perspective view of an escrow compartment, a plunger assembly, and a storage cassette according to one embodiment of the document handling device of the present invention;

FIG. 6 is a top view of an escrow compartment and plunger assembly according to one embodiment of the document handling device of the present invention;

FIG. 7 is a front view of an escrow compartment and plunger assembly according to one embodiment of the document handling device of the present invention;

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FIG. 8 is another front view of an escrow compartment and plunger assembly according to one embodiment of the document handling device of the present invention;

FIG. 9 is a perspective view of an apparatus for transferring currency from an escrow compartment to a storage cassette according to one embodiment of the document handling device of the present invention;

FIG. 10 is a perspective view of a paddle according to one embodiment of the document handling device of the present invention;

FIG. 11 is a rear perspective view of the escrow compartment, plunger assembly, and storage cassette according to one embodiment of the document handling device of the present invention;

FIG. 12 is a rear view of a plunger assembly wherein the gate is in the open position according to one embodiment of the document handling device of the present invention;

FIG. 13 is a rear view of a plunger assembly wherein the gate is in the closed position according to one embodiment of the document handling device of the present invention;

FIG. 14 is a perspective view of a storage cassette according to one embodiment of the document handling device of the present invention;

FIG. 15 is a rear view of a storage cassette according to one embodiment of the document handling device of the present invention;

FIG. 16 is a perspective view of a storage cassette showing a door in the open position according to one embodiment of the document handling device of the present invention;

FIG. 17a is a top view of a storage cassette sized to accommodate United States currency documents according to one embodiment of the document handling device of the present invention;

FIG. 17b is a rear view of a storage cassette sized to accommodate United States currency documents according to one embodiment of the document handling device of the present invention;

FIG. 18a is a top view of a storage cassette sized to accommodate large documents according to one embodiment of the document handling device of the present invention;

FIG. 18b is a rear view of a storage cassette sized to accommodate large documents according to one embodiment of the document handling device of the present invention;

FIG. 19 is a perspective view of a two belt bill facing mechanism according to one embodiment of the present invention;

FIG. 20 is another perspective view of a two belt bill facing mechanism according to one embodiment of the document handling device of the present invention;

FIG. 21 is a perspective view of a two belt bill facing mechanism without belt guides or bill guides according to one embodiment of the document handling device of the present invention;

FIG. 22 is a perspective view of a two belt bill facing mechanism without belt guides according to one embodiment of the document handling device of the present invention; and

FIG. 23 is a front view of a stack of currency bills stacked pursuant to a strapping mode of operation according to one embodiment of the present invention;

FIG. 24 is a flow charting illustrating the steps performed when operating pursuant to a strapping mode of operation according to one embodiment of the present invention;

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FIG. 25a is a front view of a stack of currency bills stacked pursuant to a strapping mode of operation according to one embodiment of the present invention; and

FIG. 25b is a front view of a stack of currency bills stacked pursuant to a strapping mode of operation according to one embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Referring to FIGS. 1a and 1b, a multi-pocket document processing device 100 such as a currency handling device according to one embodiment of the present invention is illustrated. Currency bills are fed, one by one, from a stack of currency bills placed in an input receptacle 102 into a transport mechanism 104. The transport mechanism 104 guides currency bills to one of a plurality of output receptacles 106a-106h, which may include upper output receptacles 106a, 106b, as well as lower output receptacles 106c-106h. Before reaching an output receptacle 106 the transport mechanism 104 guides the bill through an evaluation region 108 where a bill can be, for example, analyzed, authenticated, denominated, counted, and/or otherwise processed. In alternative embodiments of the currency handling device 100 of the present invention, the evaluation region 108 can determine bill orientation, bill size, or whether bills are stacked upon one another. The results of the above process or processes may be used to determine to which output receptacle 106 a bill is directed. The illustrated embodiment of the currency handling device has an overall width,  $W_1$ , of approximately 4.52 feet (1.38 meters), a height,  $H_1$ , of approximately 4.75 feet (1.45 meters), and a depth,  $D_1$ , of approximately 1.67 feet (0.50 meters).

In one embodiment, documents such as currency bills are transported, scanned, denominated, authenticated and/or otherwise processed at a rate equal to or greater than 600 bills per minute. In another embodiment, documents such as currency bills are transported, scanned, denominated, authenticated, and/or otherwise processed at a rate equal to or greater than 800 bills per minute. In another embodiment, documents such as currency bills are transported, scanned, denominated, authenticated and/or otherwise processed at a rate equal to or greater than 1000 bills per minute. In still another embodiment, documents such as currency bills are transported, scanned, denominated, authenticated, and/or otherwise processed at a rate equal to or greater than 1200 bills per minute.

In the illustrated embodiment, interposed in the bill transport mechanism 104, intermediate the bill evaluation region 108 and the lower output receptacles 106c-106h is a bill facing mechanism designated generally by reference numeral 110. The bill facing mechanism is capable of rotating a bill 180° so that the face orientation of the bill is reversed. The leading edge of the bill (the wide dimension of the bill according to one embodiment) remains constant while the bill is rotated 180° about an axis parallel to the smaller dimension of the bill) so that the face orientation of the bill is reversed. That is, if a U.S. bill, for example, is initially presented with the surface bearing a portrait of a president facing down, it may be directed to the facing mechanism 110, whereupon it will be rotated 180° so that the surface with the portrait faces up. The decision may be taken to send a bill to the facing mechanism 110 when the selected mode of operation or other operator instructions call for maintaining a given face orientation of bills as they are processed by the currency handling device 100. Using U.S. currency as an example, it may be desirable in certain

circumstances for all of the bills ultimately delivered to the lower output receptacles 106c-106h to have the bill surface bearing the portrait of the president facing up. In such embodiments of the currency handling device 100, the bill evaluation region 108 is capable of determining the face orientation of a bill, such that a bill not having the desired face orientation can first be directed to the facing mechanism 110 before being delivered to the appropriate output receptacle 106. Further details of a facing mechanism which may be utilized for this purpose are disclosed in commonly-owned, co-pending U.S. application Ser. No. 09/181,254, entitled "Document Facing Method and Apparatus" which was filed on Oct. 28, 1998, incorporated herein by reference in its entirety, which may be employed in conjunction with the present invention such as the device illustrated in FIGS. 1a and 1b. Other alternative embodiments of the currency handling device 100 do not include the facing mechanism 110.

The currency handling device 100 in FIG. 1a may be controlled from a separate controller or control unit 120 which has a display/user-interface 122, which may incorporate a touch panel display in one embodiment of the present invention, which displays information, including "functional" keys when appropriate. The display/user-interface 122 may be a full graphics display. Alternatively, additional physical keys or buttons, such as a keyboard 124, may be employed. The control unit 120 may be a self-contained desktop or laptop computer which communicates with the currency handling device 100 via a cable 125. The currency handling device 100 may have a suitable communications port (not shown) for this purpose. In embodiments in which the control unit 120 is a desktop computer wherein the display/user-interface 122 and the desktop computer are physically separable, the desktop computer may be stored within a compartment 126 of the currency handling device 100. In other alternative embodiments, the control unit 120 is integrated into the currency handling device 100 so the control unit 120 is contained within the device 100.

The operator can control the operation of the currency handling device 100 through the control unit 120. Through the control unit 120 the operator can direct the bills into specific output receptacles 106a-106h by selecting various user defined modes. In alternative embodiments, the user can select pre-programmed user defined modes or create new user defined modes based on the particular requirements of the application. For example, the operator may select a user defined mode which instructs the currency handling device 100 to sort bills by denomination; accordingly, the evaluation region 108 would denominate the bills and direct one dollar bills into the first lower output receptacle 106c, five dollar bills into the second lower output receptacle 106d, ten dollar bills into the third lower output receptacle 106e, twenty dollar bills into the fourth lower output receptacle 106f, fifty dollar bills into the fifth lower output receptacle 106g, and one-hundred dollar bills into the sixth lower output receptacle 106h. The operator may also instruct the currency handling device 100 to deliver those bills whose denomination was not determined, no call bills, to the first upper output receptacle 106a. In such an embodiment, upper output receptacle 106a would function as a reject pocket. In an alternative embodiment, the operator may instruct the currency handling device 100 to also evaluate the authenticity of each bill. In such an embodiment, authentic bills would be directed to the appropriate lower output receptacle 106c-106h. Those bills that were determined not to be authentic, suspect bills, would be delivered to the second upper output receptacle 106b. A

multitude of user defined modes are disclosed by co-pending U.S. patent application Ser. No. 08/916,100 entitled "Multi-Pocket Currency Discriminator" which was filed on Aug. 21, 1997, incorporated herein by reference in its entirety, which may be employed in conjunction with the present invention such as the device illustrated in FIGS. 1a and 1b.

According to one embodiment, the currency handling device 100 is designed so that when the evaluation region 108 is unable to identify certain criteria regarding a bill, the unidentified bill is flagged and "presented" in one of the output receptacles 106a-106h, that is, the transport mechanism 104 is stopped so that the unidentified bill is located at a predetermined position within one of the output receptacles 106a-106h, such as being the last bill transported to one of the output receptacles. Such criteria can include denominating information, authenticating information, information indicative of the bill's series, or other information the evaluation region 108 is attempting to obtain pursuant to a mode of operation. Which output receptacles 106a-106h the flagged bill is presented in may be determined by the user according to a selected mode of operation. For example, where the unidentified bill is the last bill transported to an output receptacle 106a-106h, it may be positioned within a stacker wheel or positioned at the top of the bills already within the output receptacle 106a-106h. While unidentified bills may be transported to any output receptacles 106a-106h, it may be more convenient for the operator to have unidentified bills transported to one of the upper output receptacles 106a,b where the operator is able to easily see and/or inspect the bill which has not been identified by the evaluation region 108. The operator may then either visually inspect the flagged bill while it is resting on the top of the stack, or alternatively, the operator may decide to remove the bill from the output receptacle 106 in order to examine the flagged bill more closely. In an alternative embodiment of the currency handling device 100, the device 100 may communicate to the user via the display/user-interface 122 in which one of the output receptacles 106a-106h a flagged bill is presented.

The currency handling device 100 may be designed to continue operation automatically when a flagged bill is removed from the upper output receptacle 106a,b or, according to one embodiment of the present invention, the device 100 may be designed to suspend operation and require input from the user via the control unit 120. Upon examination of a flagged bill by the operator, it may be found that the flagged bill is genuine even though it was not identified as so by the evaluation region 108 or the evaluation region 108 may have been unable to denominate the flagged bill. However, because the bill was not identified, the total value and/or denomination counters will not reflect its value. According to one embodiment, such an unidentified bill is removed from the output receptacles 106 and reprocessed or set aside. According to another embodiment, the flagged bills may accumulate in the upper output receptacles 106a,b until the batch of currency bills currently being processed is completed or the output receptacle 106a,b is full and then reprocessed or set aside.

According to another embodiment, when a bill is flagged, the transport mechanism may be stopped before the flagged bill is transported to one of the output receptacles. Such an embodiment is particularly suited for situations in which the operator need not examine the bill being flagged; for example, the currency handling device 100 is instructed to first process United States currency and then British currency pursuant to a selected mode of operation where the currency handling device 100 processes United States \$1,

\$5, \$10, \$20, \$50, and \$100 currency bills into the lower output receptacles 106c-106h, respectively. Upon detection of the first British pound note, the currency handling device 100 may halt operation allowing the operator to empty the lower output receptacles 106c-106h and to make any spatial adjustments necessary to accommodate the British currency. A multitude of modes of operation are described in conjunction with bill flagging, presenting, and/or transport halting in commonly owned, co-pending U.S. patent application Ser. No. 08/916,100 entitled "Method and Apparatus for Document Processing" which was filed on May 28, 1997, incorporated herein by reference in its entirety above, which may be employed in conjunction with the present invention such as the device illustrated in FIGS. 1a and 1b.

In the illustrated embodiment, with regard to the upper output receptacles 106a, 106b, the second upper output receptacle 106b is provided with a stacker wheel 127 for accumulating a number of bills, while the first upper output receptacle 106a is not provided with such a stacker wheel. Thus, when pursuant to a preprogrammed mode of operation or an operator selected mode or other operator instructions, a bill is to be fed to the first upper output receptacle 106a, there may be a further instruction to momentarily suspend operation of the currency handling device 100 for the operator to inspect and remove the bill. On the other hand, it may be possible to allow a small number of bills to accumulate in the first upper output receptacle 106a prior to suspending operation. Similarly, the second upper output receptacle 106b may be utilized initially as an additional one of the lower output receptacles 106c-106h. However, there is no storage cassette associated with the second upper output receptacle 106b. Therefore, when the second upper output receptacle 106b is full, operation may be suspended to remove the bills at such time as yet further bills are directed to the second upper output receptacle 106b in accordance with the selected mode of operation or other operator instructions. In an alternative embodiment of the currency handling device 100 both the first and the second upper output receptacles 106a, 106b are equipped with a stacker wheel. In such an embodiment both the upper output receptacles 106a,b may also function as the lower output receptacle 106c-106h allowing a number of bills to be stacked therein.

FIGS. 2a and 2b illustrate the evaluation region 108 according to one embodiment of the currency handling system 100. The evaluation region can be opened for service, access to sensors, clear bill jams, etc. as shown in FIG. 2a. The characteristics of the evaluation region 108 may vary according to the particular application and needs of the user. The evaluation region 108 can accommodate a number and variety of different types of sensors depending on a number of variables. These variables are related to whether the machine is authenticating, counting, or discriminating denominations and what distinguishing characteristics are being examined, e.g. size, thickness, color, magnetism, reflectivity, absorbability, transmissivity, electrical conductivity, etc. The evaluation region 108 may employ a variety of detection means including, but not limited to, a size detection and density sensor 408, a lower 410 and an upper 412 optical scan head, a single or multitude of magnetic sensors 414, a thread sensor 416, and an ultraviolet/fluorescent light scan head 418. These detection means and a host of others are disclosed in commonly owned, co-pending U.S. patent application Ser. No. 08/916,100 entitled "Multi-Pocket Currency Discriminator," incorporated by reference above.

The direction of bill travel through the evaluation region 108 is indicated by arrow A. The bills are positively driven

along a transport plate 400 through the evaluation region 108 by means of a transport roll arrangement comprising both driven rollers 402 and passive rollers 404. The rollers 402 are driven by a motor (not shown) via a belt 401. Passive rollers 404 are mounted in such a manner as to be free-wheeling about their respective axis and biased into counter-rotating contact with the corresponding driven rollers 402. The driven and passive rollers 402, 404 are mounted so that they are substantially coplanar with the transport plate 400. The transport roll arrangement also includes compressible rollers 406 to aid in maintaining the bills flat against the transport plate 400. Maintaining the bill flat against the transport plate 400 so that the bill lies flat when transported past the sensors enhances the overall reliability of the evaluation processes. A similar transport arrangement is disclosed in commonly-owned U.S. Pat. No. 5,687,963 entitled "Method and Apparatus for Discriminating and Counting Documents," which is incorporated herein by reference in its entirety.

Referring now to FIGS. 3a-3d, the input receptacle 102 of the currency handling device 100 is illustrated. A feeder mechanism such as a pair of stripping wheels 140 aid in feeding the bills in seriatim to the transport mechanism 104 which first carries the bills through the evaluation region 108. According to one embodiment, the input receptacle 102 includes at least one spring-loaded feeder paddle 142a which is pivotally mounted, permitting it to be pivoted upward and drawn back to the rear of a stack of bills placed in the input receptacle 102 so as to bias the bills towards the evaluation region 108 via the pair of stripping wheels 140. The paddle 142a is coupled to an advance mechanism 144 to urge the paddle 142a towards the stripping wheels 140. In the illustrated embodiment, motion is imparted to the advance mechanism via a spring 145. In other alternative embodiments, the advance mechanism 144 is motor driven. The advance mechanism 144 is slidably mounted to a shaft 146. The advance mechanism 144 also constrains the paddle 142a to a linear path. The advance mechanism 144 may contain a liner bearing (not shown) allowing the paddle 142a to easily slide along the shaft 146. In the embodiment illustrated, the paddle 142a may also contain channels 148 to aid in constraining the paddle 142a to a linear path along a pair of tracks 150. The paddle 142a may additionally include a roller 152 to facilitate the movement of the paddle 142a.

In the embodiment illustrated in FIGS. 3a-3d, a second paddle 142b is provided such that a second stack of bills 147 may be placed in the input receptacle 102 behind a first group of bills 149, while the first group of bills 149 is being fed into the currency handling device 100. Thus, the two feeder paddles 142a and 142b may be alternated during processing in order to permit multiple stacks of currency bills to be loaded into the input receptacle 102. In such an embodiment, the operator would retract paddle 142a and place a stack of bills into the input receptacle. Once inside the input receptacle, the operator would place the paddle 142a against the stack of bills so that the paddle 142a biases the stack of bills towards the pair of stripper wheels 140. The operator could then load a second stack of bills into the input receptacle 102 by retracting the second paddle 142b and placing a stack of bills in the input receptacle between the paddles 142a and 142b. The second paddle 142b urges the second stack of bills up against the backside of the first paddle 142a. The operator can then upwardly rotate the first paddle 142a thus combining the two stacks. The first paddle 142a is then retracted to the rear of the input receptacle and the process can be repeated. The two paddle input receptacle

allows the operator to more easily continuously feed stacks of bills to the currency handling device 100. In devices not having two feeder paddles, the operator is forced to awkwardly manipulate the two stacks of bills and the advance mechanism. Alternatively, the operator may wait for the stack of bills to be processed out of the input receptacle to add another stack, however, waiting to reload until each stack is processed adds to the total time to process a given amount of currency.

Referring to FIG. 4, a portion of the transport mechanism 104 and diverters 130a-130d are illustrated. A substantial portion of the transport path of the currency handling device 100 positively grips the bills during transport from the pair of stripping wheels 140 through the point where bills are delivered to upper output receptacle 106a or are delivered to the stacker wheels 202 of output receptacles 106b-106h. The positive grip transport path of the currency handling device 100 is less costly and weighs less than the vacuum transport arrangements of other currency processing devices.

The transport mechanism 104 is electronically geared causing all sections to move synchronously from the evaluation region 108 through the point where the bills are delivered to the output receptacles 106. Multiple small motors are used to drive the transport mechanism 104. Using multiple small, less costly motors is more efficient and less costly than a single large motor. Further, less space is consumed enabling the currency handling device 100 to be more compact. Electronically gearing the transport mechanism 104 enables a single encoder to monitor bill transportation within the currency handling system 100. The encoder is linked to the bill transport mechanism 104 and provides input to a processor to determine the timing of the operations of the currency handling device 100. In this manner, the processor is able to monitor the precise location of the bills as they are transported through the currency handling device 100. This process is termed "flow control." Input from additional sensors 119 located along the transport mechanism 104 of the currency handling device 100 enables the processor to continually update the position of a bill within the device 100 to accommodate for bill slippage. When a bill leaves the evaluation region 108 the processor expects the bill to arrive at the diverter 130a corresponding to the first lower output receptacle 106c after a precise number of encoder counts. Specifically, the processor expects the bill to flow past each sensor 119 positioned along the transport mechanism 104 at a precise number of encoder counts. If the bill slips during transport but passes a sensor 119 later within an acceptable number of encoder counts the processor updates or "re-queues" the new bill position. The processor calculates a new figure for the time the bill is expected to pass the next sensor 119 and arrive at the first diverter 130a. The processor activates a the one of the diverters 130a-f to direct the bill into the appropriate corresponding lower output receptacle 106c-106h when the sensor 119 immediately preceding the diverter 130 detects the passage of the bill to be directed into the appropriate lower output receptacle 106c-h.

The currency handling device 100 also uses flow control to detect jams within the transport mechanism 104 of the device 100. When a bill does not reach a sensor 119 within the calculated number of encoder counts plus the maximum number of counts allowable for slippage, the processor suspends operation of the device 100 and informs the operator via the display/user-interface 122 that a jam has occurred. The processor also notifies the operator via the display/user-interface 122 of the location of the jam by

indicating the last sensor 119 that the bill passed and generally the approximate location of the jam in the system. If the operator cannot easily remove the bill without damage, the operator can then electronically jog the transport path in the forward or reverse direction via the control unit 120 so that the jammed bill is dislodged and the operator can easily remove the bill from the transport path. The operator can then flush the system causing the transport mechanism 104 to deliver all of the bills currently within the transport path of the currency handling device 100 to one of the output receptacles 106. In an alternative embodiment, the user of the currency handling device 100 would have the option when flushing the system to first have the bills already within the escrow regions 116a-116f to be delivered to the respective lower storage cassettes 106c-106h so that those bills may be included in the aggregate value data for the bills being processed. The bills remaining in the transport path 104 would then be delivered to a predetermined escrow region 116 where those bills could be removed and reprocessed by placing those bills in the input receptacle 102.

Utilizing flow control to detect jams is more desirable than prior art currency evaluation machines which do not detect a jam until a sensor is actually physically blocked. The latter method of jam detection permits bills to pile up while waiting for a sensor to become blocked. Bill pile-up is problematic because it may physically halt the machine before the jam is detected and may cause physical damage to the bills and the machine. In order to remedy a jam in a prior art machine, the operator must first manually physically dislodge the jammed bills. The operator must then manually turn a hand crank which advances the transport path until all bills within the transport path are removed. Moreover, because the prior art devices permit multiple bills to pile up before a jam is detected, the integrity of the process is often ruined. In such a case, the entire stack of bills must be reprocessed.

Referring back to FIG. 1a, the illustrated embodiment of the currency handling device 100 includes a total of six lower output receptacles 106c-106h. More specifically, each of the lower output receptacles 106c-106h includes a first portion designated as an escrow compartment 116a-116f and a second portion designated as a storage cassette 118a-118f. Typically, bills are initially directed to the escrow compartments 116, and thereafter at specified times or upon the occurrence of specified events, which may be selected or programmed by an operator, bills are then fed to the storage cassettes 118. The storage cassettes are removable and replaceable, such that stacks of bills totaling a predetermined number of bills or a predetermined monetary value may be accumulated in a given storage cassette 118, whereupon the cassette may be removed and replaced with an empty storage cassette. In the illustrated embodiment, the number of lower output receptacles 106c-106h including escrow compartments 116 and storage cassettes 118 are six in number. In alternative embodiments, the currency handling device 100 may contain more or less than six lower output receptacles including escrow compartments and storage cassettes 118. In other alternative embodiments, modular lower output receptacles 106 can be implemented to add many more lower output receptacles to the currency handling system 100. Each modular unit may comprise two lower output receptacles. In other alternative embodiments, several modular units may be added at one time to the currency handling device 100.

A series of diverters 130a-130f, which are a part of the transportation mechanism 104, direct the bills to one of the lower output receptacles 106c-106h. When the diverters 130

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are in an upper position, the bills are directed to the adjacent lower output receptacle 106. When the diverters 130 are in a lower position, the bills proceed in the direction of the next diverter 130.

The vertical arrangement of the lower output receptacles 106c-106h is illustrated in FIG. 5. The escrow compartment 116 is positioned above the storage cassette 118. In addition to the escrow compartment 116 and the storage cassette 118, each of the lower output receptacles 106c-106h contains a plunger assembly 300. The plunger assembly 300 is shown during its descent towards the storage cassette 118.

Referring now to FIGS. 6 and 7, one of the escrow compartments 116 of the lower output receptacles 106c-106h is shown. The escrow compartment 116 contains a stacker wheel 202 to receive the bills 204 from the diverter 130. The stacker wheel 202 stacks the bills 204 within the escrow compartment walls 206, 208 on top of a gate 210 disposed between the escrow compartment 116 and the storage cassette 118. In an alternative embodiment, the escrow compartment 116 contains a pair of guides to aid in aligning the bills substantially directly on top of one another. The gate 210 is made up of two shutters: a first shutter 211 and a second shutter 212. The shutters 211, 212 are hingedly connected enabling the shutters 211, 212 to rotate downward approximately ninety degrees to move the gate from a first position (closed position) wherein the shutters 211, 212 are substantially co-planar to a second position (open position) wherein the shutters 211, 212 are substantially parallel. Below the gate 210 is the storage cassette 118 (not shown in FIGS. 6 and 7).

FIG. 8 illustrates the positioning of the paddle 302 when transferring a stack of bills from the escrow compartment 116 to the storage cassette 118. When the paddle descends upon the stack of bills 204 it causes shutters 211, 212 to quickly rotate in the directions referred to by arrows B and C, respectively; thus, "snapping" open the gate 210. The quick rotation of the shutters 211, 212 insures that the bills fall into the storage cassette 118 in a substantially stacked position. According to one embodiment, the paddle is programmed to descend after a predetermined number of bills 204 are stacked upon the gate 210. According to other embodiments, the operator can instruct the paddle 302 via the control unit 120 to descend upon the bills 204 stacked upon the gate 210.

Referring now to FIG. 9, the plunger assembly 300 for selectively transferring the bills 204 from an escrow compartment 116 to a corresponding storage cassette 118 and the gate 210 are illustrated in more detail. One such plunger assembly 300 is provided for each of the six lower output receptacles 106c-106h of the currency handling device 100. The plunger assembly 300 comprises a paddle 302, a base 304, and two side arms 306, 308. Each of the shutters 211, 212 comprising the gate 210 extends inwardly from corresponding parallel bars 214, 215. The bars 214, 215 are mounted for pivoting the shutters between the closed position and the open position. Levers 216, 217 are coupled to the parallel bars 214, 215, respectively, to control the rotation of the bars 214, 215 and hence of the shutters 211, 212. Extension springs 218, 219 (shown in FIG. 8) tend to maintain the position of the levers 216, 217 both in the closed and open positions. The shutters 211, 212 have an integral tongue 213a and groove 213b arrangement which prevents any bills which are stacked upon the gate 210 from slipping between the shutters 211, 212.

The base 304 travels along a vertical shaft 311 with which it is slidably engaged. The base 304 may include linear

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bearings (not shown) to facilitate its movement along the vertical shaft 311. The plunger assembly 300 may also include a vertical guiding member 312 (see FIG. 11) with which the base 304 is also slidably engaged. The vertical guiding member 312 maintains the alignment of the plunger assembly 300 by preventing the plunger assembly 300 from twisting laterally about the vertical shaft 311 when the paddle 302 forces the bills 204 stacked in the escrow area 116 down into a storage cassette 118.

Referring also to FIG. 10, the paddle 302 extends laterally from the base 304. The paddle 302 is secured to a support 314 extending from the base 304. A pair of side arms 306, 308 are hingedly connected to the base. Each of the side arms 306, 308 protrude from the sides of the base 304. Rollers 316, 318 are attached to the side arms 306, 308, respectively, and are free rolling. Springs 313a, 313b are attached to the side arms 306, 308, respectively, to bias the side arms 306, 308 outward from the base 304. In the illustrated embodiment, the spring 313a, 313b are compression springs.

The paddle 302 contains a first pair of slots 324 to allow the paddle to clear the stacker wheel 202 when descending into and ascending out of the cassette 118. The first pair of slots 324 also enables the paddle 302 to clear the first pair of retaining tabs 350 within the storage cassette (see FIG. 14). Similarly, paddle 302 contains a second pair of slots 326 to enable the paddle 302 to clear the second pair of retaining tabs 350 within the storage cassette 118 (see FIG. 14).

Referring now to FIG. 11, which illustrates a rear view of one of the lower output receptacles 106c-106h, the plunger 300 is bidirectionally driven by way of a belt 328 coupled to an electric motor 330. A clamp 332 engages the belt 328 into a channel 334 in the base 304 of the plunger assembly 300. In the embodiment illustrated in FIG. 11, two plunger assemblies 300 are driven by a single electric motor 330. In one embodiment of the currency handling device, the belt 328 is a timing belt. In other alternative embodiments, each plunger assembly 300 can be driven by a single electric motor 330. In still other alternative embodiments, there can be any combination of motors 330 to plunger assemblies 300.

FIGS. 12 and 13 illustrate the interaction between the side arms 306, 308 and the levers 216, 217 when the paddle assembly 300 is descending towards and ascending away from the storage cassette 118, respectively. Initially, before descending towards the cassette, the shutters are in a first (closed) position. In the illustrated embodiment, it is the force imparted by the paddle 302 which opens the gate 210 when the paddle descends towards the storage cassette 118. When the paddle is ascending away from the storage cassette 118, it is the rollers 316, 318 coupled to the side arms 306, 308 which engage the levers 216, 217 that close the gate 210. The levers 216, 217 shown in FIG. 12 are positioned in the open position. When descending towards the storage cassette 118, the rollers 316, 318 contact the levers 216, 217 and roll around the levers 216, 217 leaving the shutters in the open position. The side arms 306, 308 are hinged in a manner which allows the side arms 306, 308 to rotate inward towards the base 304 as the rollers 316, 318 engage the levers 216, 217. FIG. 13 illustrates the levers in the second position wherein the gate 210 is closed. When the paddle ascends out of the storage cassette, the side arms 306, 308 are biased away from the base 304. The rollers 316, 318 engage the levers 216, 217 causing the levers to rotate upward to the first position thus closing the gate.

FIGS. 14, 15, and 16 illustrate the components of the storage cassettes 118. The bills 204 are stored within the



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cassette housing 348 which has a base 349. Each storage cassette 118 contains two pairs of retaining tabs 350 positioned adjacent to the interior walls 351, 352 of the storage cassette. The lower surface 354 of each tab 350 is substantially planar. The tabs 350 are hingedly connected to the storage cassette 118 enabling the tabs 350 to downwardly rotate from a horizontal position, substantially perpendicular with the side interior walls 351, 352 of the cassette 118, to a vertical position, substantially parallel to the interior walls 351, 352 of the cassette 118. The tabs 350 are coupled to springs (not shown) to maintain the tabs in the horizontal position.

The storage cassette 118 contains a slidable platform 356 which is biased upward. During operation of the currency handling system 100, the platform 356 receives stacks of bills from the escrow compartment 116. The floor 356 is attached to a base 358 which is slidably mounted to a vertical support member 360. The base 358 is spring-loaded so that it is biased upward and in turn biases the platform 356 upward. The storage cassettes 118 are designed to be interchangeable so that once full, a storage cassette can be easily removed from the currency handling device 100 and replaced with an empty storage cassette 118. In the illustrated embodiment, the storage cassette 118 is equipped with a handle 357 in order to expedite removal and/or replacement of the storage cassettes 118. Also in the illustrated embodiment, the storage cassette 118 has a door 359 which enables an operator to remove bills from the storage cassette 118.

The storage cassettes 118 are dimensioned to accommodate documents of varying sizes. In the illustrated embodiment, the storage cassettes 118 has a height,  $H_2$ , of approximately 15.38 inches (39 cm), a depth,  $D_2$ , of approximately 9 inches (22.9 cm), and a width,  $W_2$ , of approximately 5.66 inches (14.4 cm). The storage cassette illustrated in FIG. 15 has stand-offs 362 to set interior wall 352 off a fixed distance from the interior wall 353 of the cassette housing 348. The interior walls 351, 352 aid in aligning the bills in a stack within the storage cassettes. The embodiment of the storage cassette illustrate in FIG. 15 is sized to accommodate United States currency documents. To properly accommodate United States currency documents, the interior width of the storage cassette,  $W_3$ , is approximately 2.88 inches. FIGS. 17a and 17b also illustrate an embodiment of the storage cassette 118 sized to accommodate U.S. currency documents which have a width of approximately 2.5 inches (approximately 6.5 cm) and a length of approximately 6 inches (approximately 15.5 cm). In alternative embodiments, the length of the stand-offs 362 can be varied to accommodate documents of varying sizes. For example, the embodiment disclosed in FIG. 18a and 18b has an interior width,  $W_3$  of approximately 4.12 inches (104.6 cm) and is sized to accommodate the largest international currency, the French 500 Franc note, which has width of approximately 3.82 inches (9.7 cm) and a length of approximately 7.17 inches (18.2 cm). In order to accommodate large documents and increase the interior width,  $W_3$ , of the storage cassette 118, the lengths of stand-offs 362, illustrated in FIG. 16b, are shortened.

Beginning with FIG. 7, the operation of one of the lower output receptacles 106c-106h will be described. Pursuant to a mode of operation, the bills 204 are directed by one of the diverters 130 into the escrow compartment 116 of the lower output receptacle. The stacker wheel 202 within escrow compartment 116 receives the bills 204 from the diverter 130. The stacker wheel 202 stacks the bills 204 on top of the gate 210. Pursuant to a preprogrammed mode of operation,

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once a predetermined number of bills 204 are stacked in the escrow compartment 116, the control unit 120 instructs the currency handling device 100 to suspend processing currency bills and the paddle 302 then descends from its home position above the escrow compartment 116 to transfer the bills 204 into the storage cassette 118. Once the bills 204 have been deposited in the storage cassette 118 the currency handling device resumes operation until an escrow compartment is full or all the bills within the input receptacle 102 have been processed.

Referring now to FIGS. 8 and 9 the plunger assembly 300 downwardly travels placing the paddle 302 onto of the stack of bills 204. Upon making contact with the bills 204 the paddle 302 continues to travel downward. As the paddle 302 continues its descent, the paddle 302 forces the gate 210 to snap open. The paddle 302 imparts a force to the bills 204 that is transferred to the to the shutters 211, 212 causing the shutters 211, 212 to rotate from the closed position to the open position. The rotation of the shutters 211, 212 is indicated by the arrows B and C, respectively. Once the paddle 302 imparts the amount of force necessary to rotate levers 216, 217, the extension springs 218, 219 quickly rotate the shutters 211, 212 downward, thus "snapping" the gate 210 open. The downward rotation of the shutters 211, 212 causes each of the corresponding parallel bars 214, 215 to pivot which in turn rotates the levers 216, 217. The extension springs 218, 219 maintain the shutters 211, 212 in the open position allowing the paddle 302 to descend into the storage cassette 118. The hingedly connected side arms 306, 308 retract as the rollers 316, 318 to roll around the levers 216, 217 while the plunger assembly 300 is traveling downward into the cassette 118.

Referring now to FIG. 15, once the gate 210 is opened, the bills 204 fall a short distance onto the platform 356 of the storage cassette 118 or onto a stack of bills 204 already deposited on the platform 356. The paddle 302 continues its downward motion towards the storage cassette 118 to ensure that the bills 204 are transferred to the cassette 118. Initially, some bills 204 may be spaced apart from the platform 356 or the other bills 204 within the storage cassette by retaining tabs 350. As the plunger assembly 300 continues to descend downward into the cassette, the paddle 302 continues to urge the stack of bills 204 downward causing the retaining tabs 350 to rotate downward. The bills 204 are pushed past retaining tabs 350 and onto the platform 356.

Once the plunger assembly 300 has descended into the cassette 118 a distance sufficient for the paddle 302 to clear the retaining tabs 350 allowing the retaining tabs 350 to rotate upward, the plunger assembly initiates its ascent out of the storage cassette 118. The platform 356 urges the bills 204 upward against the underside of the paddle 302. The paddle 302 is equipped with two pairs of slots 324, 326 (FIG. 9) to enable the paddle to clear the pairs of retaining tabs 350. When the paddle 302 ascends past the pairs of retaining tabs 350 the bills 204 are pressed against the lower surfaces 354 of the pairs of retaining tabs 350 by the platform 356.

Referring now to FIG. 13, when the plunger assembly 300 is traveling upward out of the cassette 118, the rollers 316, 318 on the side arms 306, 308 engage the respective levers 216, 217 and move the respective levers 216, 217 from the second (open) position to the first (closed) position to move the gate 210 from the open position to the closed position as the paddle 302 ascends into the escrow compartment 116 after depositing the bills 204 in the storage cassette 118. The paddle 302 is mounted on the base 304 above the rollers 316, 318 on the side arms 306, 308 so that the paddle 302 clears the gate 210 before the gate 210 is moved to the closed position.

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In alternative embodiments of the currency handling device 100, the output receptacles 106 can be sized to accommodate documents of varying sizes such as various international currencies, stock certificates, postage stamps, store coupons, etc. Specifically, to accommodate documents of different widths, the width of the escrow compartment 116, the gate 210, and the storage cassette 118 would need to be increased or decreased as appropriate. The document evaluation device 100 is sized to accommodate storage cassettes 118 and gates 210 of different widths. The entire transport mechanism 104 of the currency handling device 100 is dimensioned to accommodate the largest currency bills internationally. Accordingly, the document handling device 100 can be used to process the currency or documents of varying sizes.

In various alternative embodiments, the currency handling device 100 is dimensioned to process a stack of different sized currencies at the same time. For example, one application may require the processing of United States dollars (2.5 inches×6 inches, 6.5 cm×15.5 cm) and French currency (as large as 7.17 inches×3.82 inches, 18.2 cm×9.7 cm). The application may simply require the segregation of the U.S. currency from the French currency wherein the currency handling device 100 delivers U.S. currency to the first lower output receptacle 106c and the French currency to the second output receptacle 106d. In another alternative embodiment, the currency handling device 100 processes a mixed stack of U.S. ten and twenty dollar bills and French one hundred and two hundred Franc notes wherein the currency documents are denominated, counted, and authenticated. In that alternative embodiment, the U.S. ten and twenty dollar bills are delivered to the first 106c and second 106d lower output receptacles, respectively, and the French one hundred and two hundred Franc notes are delivered to the third 106e and fourth 106f lower output receptacle, respectively. In other alternative embodiments, the currency handling device 100 denominates, counts, and authenticates six different types of currency wherein, for example, Canadian currency is delivered to the first lower output receptacle 106c, United States currency is delivered to the second output receptacle 106d, Japanese currency is delivered to the third lower output receptacle 106e, British currency is delivered to the fourth lower output receptacle 106f, French currency is delivered to the fifth lower output receptacle 106g, and German currency is delivered to the sixth lower output receptacle 106h. In another embodiment, no call bills or other denominations of currency, such as Mexican currency for example, may be directed to the second upper output receptacle 106b. In another embodiment, suspect bills are delivered to the first upper output receptacle 106a.

In other alternative embodiments of the currency handling device 100, the user can vary the type of documents delivered to the output receptacles 106. For example, in one alternative embodiment an operator can direct, via the control unit 120, that a stack of one, five, ten, twenty, fifty, and one-hundred United States dollar bills be denominated, counted, authenticated, and directed into lower output receptacles 106c–106h, respectively. In still another alternative embodiment, the currency handling device 100 is also instructed to deliver other bills, such as a United States two dollar bill or currency documents from other countries that have been mixed into the stack of bills, to the second upper output receptacle 106b. In still another alternative embodiment, the currency handling device 100 is also instructed to count the number and aggregate value of all the currency bills processed and the number and aggregate value of each individual denomination of currency bills processed.

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These values can be communicated to the user via the display/user-interface 122 of the currency handling device 100. In still another alternative embodiment, no call bills and bills that are stacked upon one another are directed to the second upper output receptacle 106b. In still another alternative embodiment, the operator can direct that all documents failing an authentication test be delivered to the first upper output receptacle 106a. In another alternative embodiment, the operator instructs the currency handling device 100 to deliver no call bills, suspect bills, stacked bills, etc. to one of the lower output receptacles 106c–106h. The currency handling device 100 which has eight output receptacles 106a–106h provides a great deal of flexibility to the user. And in other alternative embodiments of the currency handling device 100, numerous different combinations for processing documents are available.

According to one embodiment, the various operations of the currency handling device 100 are controlled by processors disposed on a number of printed circuit boards ("PCBs") such as ten PCBs located throughout the device 100. In one embodiment of the present invention, the processors are Motorola processors, model number 86HC16, manufactured by Motorola, Inc. of Schaumburg, Ill. Each of the processors are linked to a central controller via a general purpose communications controller disposed on each PCB. In one embodiment of the present invention the communications controller is an ARCNET communications controller, model COM20020, manufactured by Standard Microsystems Corporation of Hauppauge, N.Y. The communications controller enables the central controller to quickly and efficiently communicate with the various components linked to the PCBs.

According to one embodiment, two PCBs, a "motor board" and a "sensor board," are associated with each pair of lower output receptacles 106c–106h. The first two lower output receptacles 106c,d, the second two lower output receptacles 106e,f, and the last two lower output receptacles 106g,h are paired together. Each of the lower output receptacles 106 contain sensors which track the movement of the bills into the lower output receptacles 106c–106h, detect whether each storage cassette 118a–118e is positioned within the currency handling device 100, detect whether the doors 359 of the storage cassettes 118 are opened or closed, and whether the cassettes 118 are full. These aforementioned sensors associated with each pair of the lower output receptacles are tied into a sensor board which is linked to the central controller. The operation of the plunger assembly 300, the stacker wheels 202, the portion of transportation mechanism 104 disposed above the lower output receptacles 106c–106h, and the diverters 130 are controlled by processors disposed on the motor board associated with each pair of lower output receptacle's 106c–106h. Those sensors 130 which track the movement of bills along the transportation mechanism 104 that are disposed directly above the lower output receptacles 106c–106h are also tied into the respective motor boards.

One of the four remaining PCBs is associated with the operation of the one or two stacker wheels 127 associated with the upper output receptacles 106a,b, the stripping wheels 140, the primary drive motor of the evaluation region 108, a diverter which direct bills to the two upper output receptacles 106a,b, and the diverter which then directs bills between the two upper output receptacles 106a,b. The remaining three PCBs are associated with the operation of the transport mechanism 104 and a diverter which directs bills from the transport path to the bill facing mechanism 110. The plurality of sensors 130 disposed along the trans-



port mechanism 104, used to track the movement of bills along the transport mechanism 104, also tied into these three remaining PCBs.

Referring now to FIGS. 19-22, a two belt bill facing mechanism 400 is illustrated. The two belt bill facing mechanism 400 is an alternative embodiment of the bill facing mechanism 110 referred to in FIGS. 1a and 1b and in the above related discussion. The two belt bill facing mechanism 400 can be used in conjunction with the currency handling device 100 shown in FIGS. 1a and 1b to rotate the face orientation of a bill 401 approximately 180°. For example, if a U.S. bill, for example, is initially presented with the surface bearing a portrait of a president facing down, it may be directed to the two belt bill facing mechanism 400, whereupon it will be rotated 180° so that the bill surface with the portrait faces up. The decision may be taken to send a bill 401 to the facing mechanism 400 when the selected mode of operation or other operator instructions call for maintaining a given face orientation of bills as they are processed by the currency handling device 100. For example, it may be desirable in certain circumstances for all of the bills ultimately delivered to the lower output receptacles 106c-106h to have the same face orientation. In such embodiments of the currency handling device 100, the bill evaluation region 108 is capable of determining the face orientation of a bill, such that a bill not having the desired face orientation can first be directed to the two belt bill facing mechanism 400 before being delivered to the appropriate lower output receptacle 106c-106h.

The two belt bill facing mechanism 400 ("facing mechanism") includes a first belt 402 and a second belt 404. Each of the first and the second belts 402,404 forms a continuous loop. The belts 402,404 are disposed adjacent to each other such that the opposing surfaces of each belt 402,404 forms a bill facing transport path 406. The belts 402, 404 are twisted together so that an inlet 408 of the transport path 406 is rotated approximately 180° with respect to an outlet 410 of the transport path 406.

The first and second belts 402, 404 are each wrapped around two rollers. The first belt 402 is positioned around a first roller 412 disposed adjacent the inlet 408 and a second roller 414 disposed adjacent the outlet 410. The second belt 404 is positioned around a third roller 416 disposed adjacent the inlet 408 and a fourth roller 418 disposed adjacent the outlet 410. As illustrated in FIG. 19, the first and second rollers 412,414, associated with the first belt, are positioned such that the first roller 412 is the "top" roller at the inlet 408 and the second roller 414 is the "bottom" roller at the outlet 410. The third and fourth rollers 416,418, associated with the second belt, are positioned such that the third roller 416 is the "bottom" roller at the inlet 408 and the fourth roller 418 is the "top" roller at the outlet 410. This arrangement allows for the "twisted" bill facing mechanism transport path 406. Starting from the inlet 408, a first end 402a of the first belt 402 is placed around the first roller 412 which is disposed above the third roller 416 around which a first end 404a of the second belt 404 is placed. Viewing FIG. 19 from right to left, the first and the second belts 402,404 are together twisted 180° out of the page. The second end 404b of the second belt 404 is now disposed above the second end 402b of the first belt 402. The second end 404b of the second belt 404 is positioned around the fourth roller 418 and the second end 402b of the first belt 402 is positioned around the third roller 414. Between the inlet 408 and the outlet 410, that is between the rollers, there is no structure supporting the portions of the first or the second belts 402,404 which define the bill transport path 406. The rollers are connected

to shafts 419 about which the rollers rotate. In one embodiment of the two belt bill facing mechanism, the rollers 414,418 are driven rollers and the rollers 412,416 are passive rollers. In such an embodiment, a motor (not shown) is coupled to the shafts 419 associated with driven rollers 414,418.

Two belt guides 420 (FIGS. 19 and 20) are used to guide the portion of the belts not defining the transport path 406 or the return portion 422 of the belts away from the transport path. The return portion 422 of the belts 402,404 is drawn away from the transport path 406 to insure that the return portion 422 does not contact a bill 401 traveling along the transport path 406 causing the bill 401 to become skewed relative to the transport path 406. Each belt guide 420 is attached to a structure 424 which is fixed to the currency handling device 100. In FIGS. 19 and 20, only the first belt guide 420 is clearly illustrated. In the illustrated embodiment, each belt guide 420 includes one vertical roller and two horizontal rollers 426. The vertical roller associated with the second belt guide 420 is labeled with reference number 427. The interior of each belt 402,404 travels against the vertical roller. Any vertical movement of the return portion 422 of the belt is constrained by the two horizontal rollers 426 along which the edges 428,429 of the belts 402,404 travel. In an alternative embodiment, the belt guide 420 only contains one horizontal roller 426 to limit the vertical movement of the return portions of the belts.

In the embodiment illustrated in FIG. 20, the two belt bill facing mechanism contains belt end guides 440. The belt end guides 440 are used to maintain the position of belts 402,404 on rollers 412, 416. The belt guides limit any horizontal movement of the belts 402, 404 at their first ends 402a,404a. In another embodiment of the two, belt bill facing mechanism two more belt end guides are used to limit any horizontal of the belts 402,404 at the second ends 402b, 404b. The belt end guides 440 consists of a structure 442 and two rollers 444. Because the belt guides 420 pull the return portion 422 away from the transport path 406, the belt guide rollers 444 maintain the belt ends on the rollers 412, 414, 416, 418 and prohibit any movement of the belts 402,404 off of the rollers 412, 414, 416, 418.

The bill facing mechanism 400 also contains four guides 431,432,433, 434 disposed along the bill transport path 406. Each of these guides are also fixed to the structures 424. The guides 431-434 are made out of a rigid material. A bill is transported through the bill facing mechanism (as well as the through the transport mechanism 104 of currency handling device 100) with the leading edge of the bill being the long or wide edge of the bill 401. The width of the bill 401 is greater than the width of the first and the second belts 402,404 causing a significant portion of the bill 401 to overhang each edge of the belts 402,404. The function of the guides is to provide support to those portions of the bill 401 which overhang the belts 402,404. Because of the high processing rate at which the currency handling device 100 operates, a significant angular velocity is imparted to a bill directed through the facing mechanism. In alternative embodiments of the currency handling device 100, bills are processed at speeds in excess of 1200 bills per minute. The differences in air pressures acting on the front and the back surfaces areas of the bill 401 can cause the bill 401 to fold or be forced such that the bill is no longer being transported in a substantially flat manner. This situation can occur more readily when the bill stiffness is degraded due to bill wear resulting from heavy usage. Additionally, bills are often folded in a variety of manners which may cause a bill to be biased in a certain direction such that the bill will not lie flat

under its own weight. It is preferable for the bill 401 to be transported through the bill facing mechanism 400 (and the currency handling device 100) in a substantially flat manner. If the bill 401 is not substantially flat when traveling from the outlet 410 of the bill facing mechanism 400 back into the bill transport mechanism 104 there is a possibility that the bill may become skewed at the interface between the outlet 410 and the transport mechanism 104 because the transport mechanism 104 may not "catch" the entire leading edge of the bill.

In operation, a bill 401, shown in position E, enters the inlet 408 of the bill facing mechanism 400 and is transported along the bill facing transport path 406 in a direction from right to left indicated by arrow D. The bill 401 adjacent to the outlet 410 is shown in position F which is a 180° rotation from position E. Referring to the bill 401 in position E, the bill 401 has narrow edges 450, 451 and surfaces 452, 453. The first and second belts 402, 404, a portion of which define the transport path 406, are twisted causing the bill 401 to rotate in manner such that the (near) edge 450 of the bill 401 drops into the page and the (far) edge 451 of the bill 401 rotates up and out of the page. As the bill 401 travels through the bill transport path 406, the surface 452 towards the (near) edge 450 of the bill 401 is guided by the first guide 431. The surface 453 towards the (far) edge 451 of the bill 401 is supported by the second guide 432. The guides 431, 432 support their respective surfaces of the bill 401 until the bill 401 is substantially in a vertical position. As the bill continues to travel towards the outlet 410 the edge 451 (now at the top of the page) continues to rotate out of the page while the edge 450 (now at the bottom of the page) rotates into the page. Continuing, the surface 453 towards the edge 451 is being guided by the guide 433. The surface 452 towards edge 450 is being guided by the guide 434. When the bill arrives at the outlet 410, the orientation of the bill has been rotated 180°. The bill then merges into the transport mechanism 104 of the currency handling device 104.

In another alternative embodiment, the currency handling device 100 operates in a strapping mode wherein pursuant to a user's input or selection of a preprogrammed mode of operation, currency bills are stacked in a manner so that smaller stacks of bills within a larger stack of bills are readily identifiable. Typically, in the handling of bulk currency, after the currency bills have been analyzed, denominated, authenticated, counted, and/or otherwise processed, the currency bills are strapped. Bill strapping is a process whereby a stack of a specific number of bills of a single denomination are secured together such as with a paper strap. For example, one dollar bills are segregated into stacks of one-hundred one dollar bills and then bound with a paper strap. Strapping facilitates the handling of bulk currency allowing the strapped stacks of bills to be counted rather than the individual currency bills.

When operating pursuant to a strapping mode, the currency handling device 100 stacks currency bills in the lower output receptacles 106c-106h in a manner so that smaller batches of currency bills are readily identifiable such as by alternating the face orientation of the smaller batches of bills within the stack. Put another way, as illustrated in FIG. 23, every other smaller stack 550 of bills comprising the larger stack 552 of bills is either orientated with the surface of the bill bearing the portrait of the president face-up or face-down. This arrangement allows a user of the currency handling device 100 to quickly segregate the smaller stacks 550 from the larger stack 552 of bills for strapping purposes after the user removes the larger stack 552 of bills from the storage cassette 118a-f associated with a corresponding

lower output receptacle 106c-h. For example, a user desiring to "strap" U.S. \$20 bills would instruct the currency handling device accordingly, so that the face-orientation of every batch of one-hundred \$20 bills would alternate.

A bill turnover mechanism, such as for example, either the two belt bill facing mechanism 400, illustrated in FIGS. 19-22, or the bill facing mechanism 110, referred to in FIGS. 1a and 1b, can be incorporated into the currency handling device 100 to vary the face orientation of the bills pursuant to a strapping mode so that the individual currency bills within each smaller stack 550 of currency bills has a common face orientation. Alternatively, in other embodiments of the present invention, other turnover mechanisms can be used.

The total number of bills per smaller stack 550 of currency bills is referred to as a "limit." The "limit" is a predetermined number which is either defined by the user of the currency handling system 100 or is defined by a mode of operation. In one embodiment, the user defines via the user interface 122 that the limit is, for example, fifty currency bills. Accordingly, the face orientation of every fifty currency bills is alternated. In another alternative embodiment, a user selects via the user interface 122 a "\$20 strapping mode" wherein, for example, the limit is predefined at one hundred \$20 bills. While any number of bills can be included in a strap of currency bills, U.S. currency bills are traditionally strapped in one-hundred bill stacks.

Referring also to FIG. 24, the steps performed in a strapping mode of operation will be described in detail. For purposes of this example, the stack of bills consists of U.S. \$20 bills arranged in both face orientations. Initially at steps 502, 504, and 506, the limit is defined, the bill count is set to zero, and the target orientation is defined, respectively. The target face orientation is the face orientation in which the first smaller stack of bills are to have when stacked in a particular output receptacle 106c-106h such as output receptacle 106f. The target orientation, either face-up or face-down, can be predetermined pursuant to a mode of operation or be input by a user at step 506. In an alternative embodiment of the currency handling device 100, the target orientation can be defined as the orientation of the first currency bill transported through the evaluation region 108 or the first currency bill of a given denomination transported through the evaluation region 108. The initial target orientation dictates the orientation of the first smaller currency bill stack 550 stacked on the platform 356 of a particular storage cassette 118a-f. Accordingly, the initial target orientation of the strapping mode which resulted in the stack of currency bills illustrated in FIG. 23 was face-up.

Upon the commencement of the operation of the currency handling device 100, the bills are transported one at a time through the evaluation region 108 to one of the output receptacles 106c-h. At step 508, while being transported through the evaluation region 108, the face orientation of each of the bills is determined. The face orientation of the bill currently being evaluated is compared to the target orientation at 510. If the orientation of the currency bill currently being evaluated matches the target orientation, the face orientation of the bill is maintained at step 512 and the bill is transported to a particular one of the output receptacles 106c-h at step 514. If the orientation of the currency bill currently being evaluated fails to match the target orientation, the bill is first transported to the bill facing mechanism 400 at step 516, where the face orientation of the bill is reversed as the bill is rotated 180°. The properly faced bill is then transported to and stacked in a particular one of the output receptacles 106c-h at step 514. As each bill is

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transported to the output receptacle 106c-106h, at step 516, a bill counter increases by one until the number of bills transported to the particular output receptacle 106c-h having a common face orientation is equivalent to the strap limit. The strap limit is compared to the bill count at step 518. When the bill count is equivalent to the strap limit, the target face orientation is redefined to be the other of the two face orientations—face-up or face-down—at step 520. The bill count is then reset to zero at step 522. The currency evaluation device continues to operate in this manner until the entire batch of currency bills is processed.

The foregoing is one example of the steps performed in processing currency bills with the currency handling device 100 pursuant to a stacking mode of operation. In alternative embodiments, the sequence in which the steps are performed can be rearranged in a variety of other orders or combined. For example, in an alternative embodiment, the steps Define The Limit 502, Set Bill Count To Zero 504, and Define The Target Orientation 506 can be combined in a preprogrammed strapping mode of operation which the user simply selects from the user interface 122. For example, a “\$50 strapping” mode of operation may be selected by the user, via the user interface 122, wherein the limit is predefined at one-hundred bills, the bill count is set to zero, and the initial target orientation is defined as face-down.

In alternative embodiments of the present invention, the currency bills can be processed into the lower output receptacles 106c-h in a variety of manners. For example, in one embodiment, bills are processed into the escrow region 116 until the escrow region 116 is full. At that time, the plunger assembly 300 transfers the bills from the escrow region 116 to the corresponding storage cassette 118. The currency handling device 100 operates in this manner until all of the bills have been processed into the storage cassette(s) 118. If, after all of the bills have been processed, a smaller stack of bills has been delivered to a storage cassette 118 containing a number of bills which is less than the strap limit, the currency handling device 100 can notify the user via the user interface 122. In still another alternative embodiment, after a number of bills equivalent to the strap limit are processed into the escrow region 116, the plunger assembly 300 transfers the bills to the storage cassette 300. In this embodiment of a strapping mode of operation, all of the smaller stacks of bills in the storage cassette comprise a number of bills equivalent to the strap limit. A stack of bill comprising a number of currency bill less than the limit remains in the escrow region until either the stack is removed by the operator of the currency handling device 100 or until the stack is supplemented with bills from an additional batch of currency processed by the currency handling device.

After the entire batch of currency bills is processed into the lower output receptacles 106c-h pursuant to a strapping mode of operation, a user of the currency handling device 100 removes the stacks of bills from each storage cassette 118a-f associated with corresponding lower output receptacles 106c-h. Because the smaller stacks of bills within each of the larger stacks of bills removed from the storage cassettes 118a-f are arranged with alternating face orientations, the user can quickly segregate the smaller stacks from the larger stacks and bind each of the smaller stacks with a strap.

In an alternative embodiment of the present invention, larger stacks of bills comprising smaller stacks of bills having alternative face orientations, such as illustrated in FIG. 23, can be formed in the lower output receptacles 106c-h without using the bill facing mechanism. In such an embodiment, face-up bills are transported to a “target” lower

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output receptacle and face-down bills are transported to another target lower output receptacle until the limit is reached in both lower output receptacles. The target receptacles 106 are then switched and the process is repeated. For example, bills of a given denomination having a face-up orientation are routed to the first lower output receptacle 106c and bills of the same denomination having a face-down orientation are routed to the second lower output receptacle 106d. Face-up and face-down bills continue to be processed into the first and second lower output receptacles 106c,d, respectively, until a number of bills equivalent to the limit have been processed into the first and second lower output receptacles 106c,d. At that time, the face-up bills are then routed to the second lower output receptacle 106d and the face-down bills are routed to the first lower output receptacle 106c. Bills continue to be processed in this manner until the limit is again reached in both the first and second lower output receptacles 106c,d at which time the target lower output receptacles 106 of the face-up and face-down bills are again switched. The process continues as described until the entire batch of currency is processed and each of the lower output receptacles 106c,d contain larger stacks of bills comprising smaller stacks having alternating face orientations. Obviously, the limit will be reached in one of the two lower output receptacles 106c,d before the other of the two lower output receptacles 106c,d. Accordingly, the excess bills are off-sorted or, alternatively, a similar method is performed in the adjacent lower output receptacles 106e,f. For example, when the limit is first reached with respect to face-up bills directed to the first lower output receptacle 106c, those face-up bills are then routed to the third lower output receptacle 106e while face-down bills continue to be directed to the second lower output receptacles 106d. Should the limit be reached in the third lower output receptacle 106e before the second lower output receptacle 106d, the face-up bills can then be directed to the next lower output receptacle 106f. When the limit in the second output receptacle 106d is eventually reached, the target lower output receptacles 106c,d of the face-up and face-down bills can be switched as described. While the above example was discussed in conjunction with the processing of only one denomination of currency bills, in other alternative embodiments more than one denomination of currency bills can be processed in a similar manner.

In still other alternative embodiments of the present invention, smaller stacks of bills can be distinguished, for strapping purposes, from larger stacks of bills processed into lower output receptacles in a variety of other manners without alternating the face orientation of consecutive smaller stacks of bills. In one alternative embodiment, dividers such as sheets of paper are injected into the flow of currency bills so that the sheets of paper are disposed between each of the smaller stacks of currency bills. These “separation sheets” may be any one of a variety of colors that are readily distinguishable from the currency bills being processed such as, for example, fluorescent orange, pink, yellow, red, etc. Sheets which are readily distinguishable from the currency bills being processed will facilitate the user’s identification and segregation of the smaller stacks of currency bills within the larger stack. In other embodiments, a marking on the “separation sheets” denoting the quantity of bills, the denomination of the bills, and/or the value of each smaller stack of bills may provide information to the user of the currency handling device 100.

In still another alternative embodiment, rather than reversing the face orientation of the bills to distinguish the smaller stacks of currency bills, each of the smaller stacks

554 are slightly offset from the previous smaller stack as illustrated in FIG. 25a. In such an embodiment, each consecutive smaller stack 554 of bills comprising the larger 556 stack may be offset so that the larger stack 556 of bills appear "stepped" in shape. Alternatively, as illustrated in FIG. 25b, each smaller stack of bills 558 are off-set to the left and to the right of a center C of the platform 356 of the storage cassette 118 in which the bills are stacked so that the side of the larger stack of bills 560 appear corrugated in shape.

Many of the aforementioned modes of operation can be combined with a strapping mode in a multitude of alternative embodiments of the present invention. For example, in an alternative embodiment of the present invention, several denominations of U.S. currency bills may be processed pursuant to a strapping mode of operation. In such an embodiment U.S. \$1, \$5, \$10, \$20, \$50, and \$100 bills are processed pursuant to a strapping mode of operation into the lower output receptacles 106c-106h, respectively—while alternating the face orientation of every set of one-hundred bills within each of the output receptacles. Accordingly, in such an embodiment, the currency handling device must denominate each of the currency bills being processed. Continuing with the current example, when a non-U.S. \$1, \$5, \$10, \$20, \$50, or \$100 bill is detected, such as a Canadian \$1 bill or a U.S. \$2 bill, that bill is off sorted to one of the upper output receptacles 106a,b. Further, the currency handling device 100 can also authenticate each of the currency bills being processing pursuant to a strapping mode of operation. Non-authentic bills can be routed to upper output receptacles 106a,b as well. Alternatively, non-authentic bills can be routed to upper output receptacle 106a and non-U.S. \$1, \$5, \$10, \$20, \$50, or \$100 bills or no call bills are routed to upper output receptacles 106b.

In other alternative embodiments, the currency handling device 100 is capable of denominating, authenticating, and facing for strapping purposes batches of bills containing several different international currencies. For example, in one embodiment of the present invention, a user may desire to segregate, denominate, authenticate, and stack for strapping purposes U.S. \$20, \$50, \$100 bills and Canadian \$20, \$50, \$100 bills. The U.S. \$20, \$50, \$100 dollar bills may be directed to the first three lower output receptacles 106c-e and the Canadian \$20, \$50, \$100 bills may be directed to the second three lower output receptacles 106f-h. Accordingly, the currency handling device must denominate each of the currency bills before directing the bills to a lower output receptacle 106c-h. Non-U.S. \$20, \$50, \$100 bills and non-Canadian \$20, \$50, \$100 are directed to one of the upper output receptacles 106a,b such as the second upper output receptacle 106b. The bills may also be authenticated. Authentic U.S. \$20, \$50, \$100 bills and Canadian \$20, \$50, \$100 are directed to the appropriate lower output receptacles 106c-h. Those bills which are not authenticated, suspect bills, can be routed to the first upper output receptacle 106a. Further, non-U.S. \$20, \$50, \$100 suspect bills and non-Canadian \$20, \$50, \$100 suspect bills can also be directed to the first upper output receptacle 106a. Additionally, in other alternative embodiments of the present invention, modular output receptacles can be added so that, for example, U.S. \$5 and \$10 bills are processed in the same manner along side the U.S. \$20, \$50, \$100 bills and Canadian \$20, \$50, \$100 bills.

As is apparent from the foregoing discussion, a strapping mode of operation can be combined with other modes of operation to instruct the currency handling device to operate in a multitude of different variations.

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and herein described in detail. It should be understood, however, that it is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A method of creating identifiable smaller stacks of currency bills within a larger stack of currency bills using a currency evaluation device, the method comprising:

(a) receiving a stack of currency bills in an input receptacle;

(b) transporting the bills from the input receptacle, one at a time, past an evaluating unit to at least one output receptacle;

(c) identifying the face orientation of each of the bills with the evaluating unit; and either

(1) maintaining the orientation of a bill when the orientation of the bill matches a target orientation; or

(2) reversing the orientation of a bill when the orientation of the bill does not match the target orientation;

(d) stacking a predetermined number of bills in the at least one output receptacle, the predetermined number of bills having a common face orientation;

(e) redefining the target orientation to be the other of the two face orientations after the predetermined number of bills have been transported to the at least one output receptacle; and

(f) repeating (b), (c), (d), and (e), until each of the bills are transported from the input receptacle.

2. The method of claim 1 further comprising determining the authenticity of each of the currency bills.

3. The method of claim 1 further comprising determining the denomination of each of the currency bills.

4. The method of claim 3 further comprising totaling the value of the currency bills transported to the at least one output receptacle.

5. The method of claim 1 wherein the at least one output receptacle comprises a plurality of output receptacles.

6. The method of claim 5 further comprising: determining the authenticity of each of the currency bills; and

routing a bill to a particular one of the plurality of output receptacles when the authenticity of the bill cannot be determined.

7. The method of claim 5 further comprising:

determining the denomination of each of the currency bills; and

routing a bill to a particular one of the plurality of output receptacles when the denomination of the bill cannot be determined.

8. The method of claim 1 further comprising defining an initial target orientation to be the face orientation of a first bill transported from the input receptacle.

9. The method of claim 1 wherein reversing the face orientation of a bill further comprises reversing the face orientation of a bill with a bill facing mechanism.

10. A method of creating identifiable smaller stacks of currency bills within a larger stack of currency bills using a currency evaluation device, the method comprising:

(a) defining a target orientation to be one of two face orientations, one of the two face orientations being face-down, the other of the two face orientations being face-up;

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(b) receiving a stack of currency bills in an input receptacle;

(c) transporting each of the bills from the input receptacle, one at a time, past an evaluating unit to at least one output receptacle;

(d) identifying the face orientation of each of the bills with the evaluating unit; and either

- (1) maintaining the orientation of the bill when the orientation of the bill matches the target orientation; or
- (2) reversing the orientation of the bill when the orientation of the bill does not match the target orientation;

(e) stacking a predetermined number of bills in the at least one output receptacle, the predetermined number of bills having a common face orientation;

(f) redefining the target orientation to be the other of the two face orientations after a predetermined number of bills having been transported to the at least one output receptacle; and

(g) repeating (c), (d), (e), and (f) until each of the bills are transported from the input receptacle.

11. The method of claim 10 further comprising determining the authenticity of each of the currency bills.

12. The method of claim 10 further comprising determining the denomination of each of the currency bills.

13. The method of claim 12 further comprising totaling the value of the currency bills transported to the output receptacle.

14. The method of claim 10 wherein the at least one output receptacle comprises a plurality of output receptacles.

15. The method of claim 14 further comprising:

- determining the authenticity of each of the currency bills; and
- routing a bill to a particular one of the plurality of output receptacles when the authenticity of the bill cannot be determined.

16. The method of claim 14 further comprising:

- determining the denomination of each of the currency bills; and
- routing a bill to a particular one of the plurality of output receptacles when the denomination of the bill cannot be determined.

17. The method of claim 10 wherein defining a target orientation further comprises defining the target orientation to be the face orientation of a first bill transported from the input receptacle.

18. The method of claim 10 wherein reversing the orientation of a bill further comprises reversing the face orientation of a bill with a bill facing mechanism.

19. A method of creating identifiable smaller stacks of currency bills within a larger stack of currency bills with a currency evaluation device, the method comprising:

- receiving a stack of currency bills in an input receptacle;
- transporting each of the bills from the input receptacle, one at a time, past an evaluating unit to at least one output receptacle;
- identifying the face orientation of each of the bills with the evaluating unit, the face orientation of the bills being one of two face orientations, one of the two face orientations being face-down, the other of the two face orientations being face-up;
- defining a target orientation to be the face orientation of a first bill transported from the input receptacle;
- comparing the face orientation of each of the bills with the target orientation;

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maintaining the face orientation of a bill when the face orientation of the bill matches the target orientation;

reversing the face orientation of a bill when the face orientation of the bill does not match the target orientation;

stacking a predetermined number of bills in the at least one output receptacle, the predetermined number of bills having a common face orientation;

redefining the target orientation to be the other of the two face orientations after the predetermined number of bills having a common face orientation have been stacked in the at least one output receptacle; and

repeating the above method, beginning with transporting the bills until each of the bills are transported from the input receptacle.

20. The method of claim 19 further comprising determining the authenticity of each of the currency bills.

21. The method of claim 19 further comprising determining the denomination of each of the currency bills.

22. The method of claim 21 further comprising totaling the value of the currency bills transported to the output receptacle.

23. The method of claim 19 wherein the at least one output receptacle comprises a plurality of output receptacles.

24. The method of claim 23 further comprising:

- determining the authenticity of each of the currency bills; and
- routing a bill to a particular one of the plurality of output receptacles when the authenticity of the bill cannot be determined.

25. The method of claim 23 further comprising:

- determining the denomination of each of the currency bills; and
- routing a bill to a particular one of the plurality of output receptacles when the denomination of the bill cannot be determined.

26. The method of claim 19 wherein reversing the face orientation of a bill further comprises reversing the face orientation of a bill with a bill facing mechanism.

27. A method of creating identifiable smaller stacks of currency bills within a larger stack of currency bills with a currency evaluation device, the method comprising:

- receiving a stack of currency bills of a plurality of denominations in an input receptacle;
- transporting the bills from the input receptacle, one at a time, past an evaluating unit to a plurality of output receptacles, the plurality of output receptacles corresponding to the plurality of denominations;
- assigning a target orientation to each of the plurality of output receptacles,
- defining the target orientation assigned to each of the plurality of output receptacles to be one of two face orientations, one of the two face orientations being face-down, the other of the two face orientations being face-up;
- determining the denomination and face orientation of each of the bills with the evaluating unit;
- comparing the face orientation of a bill with the target orientation assigned to the output receptacle corresponding to the determined denomination of the bill;
- maintaining the orientation of the bill when the orientation of the bill matches the target orientation;
- reversing the orientation of the bill when the orientation of the bill does not match the target orientation;

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routing the bill to the output receptacle corresponding to the determined denomination of the bill;

redefining the target orientation assigned to an output receptacle to be the other of the two face orientations after a predetermined number of bills of having a denomination corresponding to the output receptacle have been routed to the output receptacle with a common face orientation; and

repeating the above method, beginning with transporting the bills until each of the bills are transported from the input receptacle.

28. The method of claim 27 further comprising determining the authenticity of each of the currency bills.

29. The method of claim 28 further comprising off-sorting a bill to a particular one of the plurality of output receptacles when the authenticity of the bill can not be determined.

30. The method of claim 27 further comprising totaling the value of the bills transported to the output receptacle.

31. The method of claim 27 further comprising off-sorting a bill to a particular one of the plurality of output receptacles when the denomination of the bill can not be determined.

32. The method of claim 27 wherein reversing the face orientation of a bill further comprises reversing the face orientation of a bill with a bill facing mechanism.

33. A method of creating identifiable smaller stacks of currency bills within larger stacks of currency bills using a currency evaluation device, the method comprising:

- (a) defining a target face orientation to be one of two face orientations for each of a plurality of currency bill denominations, one of the two face orientations being face-down, the other of the two face orientations being face-up;
- (b) receiving a stack of currency bills of a plurality of denominations in an input receptacle;
- (c) transporting the bills from the input receptacle, one at a time, past an evaluating unit to a plurality of output receptacles, the plurality of output receptacles corresponding to the plurality of denominations;
- (d) determining the denomination of each of the currency bills with the evaluating unit;
- (e) identifying the face orientation of each of the bills with the evaluating unit; and either
  - (1) maintaining the orientation of a bill when the orientation of the bill matches the target orientation associated with the determined denomination of the bill; or
  - (2) reversing the orientation of a bill when the orientation of the bill does not match the target orientation associated with the determined denomination of the bill;
- (f) routing each of the bills to one of the plurality of output receptacles corresponding to the determined denomination of the bill;
- (g) stacking a predetermined number of bills in the plurality of output receptacles corresponding to the determined denominations of the bills;
- (h) redefining the target orientation associated with a particular denomination after a predetermined number of bills have been routed to the particular output receptacle corresponding to the particular denomination; and
- (i) repeating (c), (d), (e), (f), (g), and (h) until each of the bills are transported from the input receptacle.

34. The method of claim 33 further comprising determining the authenticity of each of the currency bills.

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35. The method of claim 34 further comprising routing a bill to a particular one of the plurality of output receptacles when the authenticity of the currency bill can not be determined.

36. The method of claim 33 further comprising totaling the value of the currency bills transported to the output receptacle.

37. The method of claim 33 further comprising routing a bill to a particular one of the plurality of output receptacles when the denomination of the currency bill can not be determined.

38. The method of claim 33 wherein defining a target face orientation further comprises defining the target face orientation to be the face orientation of a first bill transported from the input receptacle.

39. A currency evaluation device for receiving a plurality of bills and evaluating and arranging the bills in a stack, wherein the stack includes a plurality of identifiable smaller stacks, the device comprising:

- an input receptacle adapted to receive a plurality of bills to be processed;
- at least one output receptacle adapted to receive the bills after the bills have been processed;
- a transport mechanism adapted to transport the bills, one at a time, from the input receptacle to the at least one output receptacle;
- an evaluating unit adapted to determine the face orientation of each of the bills and to produce a signal indicative of the face orientation of each of the bills;
- a bill facing mechanism adapted to rotate a bill approximately 180° to reverse the face orientation of a bill; and
- a controller adapted to receive the signal from the evaluating unit and to cause the transport mechanism to direct a bill to the bill facing mechanism when the face orientation of the bill does not match a target orientation so that a predetermined number of bills are transported to the output receptacle with a common face orientation, the controller being adapted to redefine the target orientation after a predetermined number of bills are transported to the output receptacle with a common face orientation.

40. The currency evaluation device of claim 39 wherein an initial target orientation is the face orientation of a first bill transported from the input receptacle.

41. The currency evaluation device of claim 39 further comprising a user interface being adapted to receive operational instructions from an operator and to display information concerning the bills.

42. The currency evaluation device of claim 41 wherein the operational instructions define an initial target orientation.

43. The currency evaluation device of claim 41 wherein the operational instructions define the predetermined number.

44. The currency evaluation device of claim 39 wherein the evaluating unit is adapted to determine the denomination of the bills.

45. The currency evaluation device of claim 44 wherein the evaluating unit is adapted to determine the value of the currency bills transported to the at least one output receptacle.

46. The currency evaluation device of claim 39 wherein the evaluating unit is adapted to determine the authenticity of the bills.

47. The currency evaluation device of claim 39 wherein the at least one output receptacle comprises a plurality of output receptacles.



48. The currency evaluation device of claim 47 wherein the evaluating unit is adapted to determine the denomination of each of the bills and to produce a signal indicative of the determined denomination of the bill, the controller being adapted to receive the signal indicative of the determined denomination and to route the bill to a particular one of the plurality of output receptacles based on the determined denomination.

49. The currency evaluation device of claim 48 wherein the evaluating unit is adapted to produce a no call error signal when the denomination of a bill cannot be determined, the controller being adapted to receive the no call error signal and to route the bill triggering the no call error signal to a particular one of the plurality of output receptacles.

50. The currency evaluation device of claim 47 wherein the evaluating unit is adapted to determine the authenticity of each of the bills and to produce suspect document error signal when the authenticity of the bill cannot be determined, the controller being adapted to receive the suspect document error signal and to route the bill triggering the suspect document error signal to a particular one of the plurality of output receptacles.

51. A currency evaluation device for receiving a plurality of bills of mixed denominations and evaluating and arranging the bills in larger stacks, wherein the larger stacks include a plurality of identifiable smaller stacks of currency bills, the device comprising:

an input receptacle adapted to receive a stack of bills of a plurality of denominations;

a plurality of output receptacles adapted to receive the bills after the bills have been evaluated, the plurality of output receptacles corresponding to the plurality of denominations;

a transport mechanism adapted to transport the bills, one at a time, from the input receptacle to the plurality of output receptacles;

an evaluating unit adapted to determine the denomination and the face orientation of each of the bills;

a bill facing mechanism adapted to rotate a bill approximately 180° to reverse the face orientation of a bill; and

a controller adapted to cause the transport mechanism to direct a bill to the bill facing mechanism when the face orientation of the bill does not match a target orientation associated with the determined denomination of the bill, the controller being adapted to cause the transport mechanism to direct a bill to the output receptacle associated with the determined denomination of the bill, the controller being adapted to redefine the target orientation associated with a particular denomination after a predetermined number of bills are transported to the output receptacle associated with the particular denomination with a common face orientation.

52. The currency evaluation device of claim 51 wherein an initial target orientation is the face orientation of a first bill transported from the input receptacle.

53. The currency evaluation device of claim 51 further comprising a user interface being adapted to receive operational instructions from an operator and to display information concerning the bills.

54. The currency evaluation device of claim 53 wherein the operational instructions define an initial target orientation.

55. The currency evaluation device of claim 53 wherein the operational instructions define the predetermined number.

56. The currency evaluation device of claim 51 wherein the evaluating unit is adapted to determine the value of the currency bills transported to the plurality of output receptacles.

57. The currency evaluation device of claim 51 where the controller is adapted to caused the transport mechanism to direct a bill to a particular one of the plurality of output receptacles when the evaluating unit cannot determine the denomination of the bill.

58. The currency evaluation device of claim 51 wherein the evaluating unit is adapted to determine the authenticity of the bills.

59. The currency evaluation device of claim 51 where the controller is adapted to caused the transport mechanism to direct a bill to a particular one of the plurality of output receptacles when the evaluating unit cannot determine the authenticity of the bill.

60. A method of creating identifiable groups of currency bills within a stack of currency bills with a currency evaluation device having a bill facing mechanism, the method comprising:

receiving a stack of currency bills in an input receptacle; transporting each of the bills from the input receptacle, one at a time, past an evaluating unit to at least one output receptacle;

identifying the face orientation of each of the bills with the evaluating unit;

stacking the bills in the at least one output receptacle such that the face orientation of each group of bills stacked in the at least one output receptacles alternates from the previous group of bills stacked in the at least one output receptacle each group comprising a predetermined number of bills.

61. The method of claim 60 further comprising determining the authenticity of each of the currency bills.

62. The method of claim 60 further comprising determining the denomination of each of the currency bills.

63. The method of claim 62 further comprising totaling the value of the currency bills transported to the output receptacle.

64. The method of claim 60 wherein the at least one output receptacle comprises a plurality of output receptacles.

65. The method of claim 64 further comprising:

determining the authenticity of each of the currency bills; and

routing a bill to a particular one of the plurality of output receptacles when the authenticity of the bill cannot be determined.

66. The method of claim 64 further comprising:

determining the denomination of each of the currency bills; and

routing a bill to a particular one of the plurality of output receptacles when the denomination of the bill cannot be determined.

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